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OF THE

National Fire Protection Association

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40 CENTRAL STREET, BOSTON, MASS.

National Fire Protection Association.

INTERNATIONAL.

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West Virginia Inspection Bureau.
Wisconsin Inspection Bureau.

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Reports of fires appearing in the Quarterly are copies of or extracts from written reports forwarded to the Association. This Association, as a body, is not responsible for the statements or opinions of any of its members.

Ruins of the frame annex building of the Illinois State Hospital for the Insane at Dunning, in which eighteen persons were burned to death on December 26, 1923. See editorial on opposite page and report on page 226.

The Evil Wooden Shingle.

Fort Wayne, Ind., had 1,012 fires in 1923. Four hundred forty-one were from sparks from the home chimney on shingle roofs. Sixty-eight were from sparks or brands from neighboring fires alighting on shingle roofs. The city government refused to pass a proposed ordinance prohibiting these inflammable roof-coverings "because no statistics on this hazard were available."

The Quarterly

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The Dunning Asylum Holocaust.

The disastrous fire in the Illinois State Hospital for the Insane at Dunning, on December 26, 1923 (see report on page 226), lengthens the already long list of institutional holocausts. Eighteen persons, fifteen of whom were insane, met death in this fire.

The past history of this institution is interesting. In 1912 the superintendent had called attention to the serious conditions then existing. On August 23, 1911, one of the buildings had been destroyed by fire. On January 17, 1912, another building burned to the ground. This building, built in 1870, had been condemned in 1908 but was forced back into use without remodeling because of overcrowded conditions. On May 4, 1914, another building was burned. On October 16, 1916, two barns on the grounds were destroyed by fire. On December 11, 1918, the tuberculosis ward, with 400 patients inside, took fire. The patients were rescued with great difficulty. After this fire the ward was rebuilt the same as before.

Apparently these previous warnings had little effect as no loss of life had occurred. Now that the inevitable has happened the usual wave of public indignation and the "startling revelation" that other asylums and institutions in the state are in similar or worse condition has followed. It is too soon, as this issue goes to press, to report the conclusions of the many investigating committees that are seeking to place the blame for this holocaust. In the last analysis the real blame lies on the indifference of the public generally toward the safety of the helpless. The institutional holocaust is not a new horror previously unknown. It is an old story. During the past year the Ward's Island Asylum fire in New York with its toll of 27 lives, the Allegheny County Alms House fire near Buffalo in which nine inmates were burned to death, and now the Dunning disaster, have been added to the gruesome record.

It would seem that the officials responsible for the safety of these unfortunates could not claim ignorance of the danger, in the face of these fatal fires which recur again and again. Yet the president of the State Board of Public Welfare, after a "thorough investigation" of the circumstances of this fire, is reported to have issued a statement which read in part as follows:

> Preliminary investigation reveals the following: That the loss of life among the patients occurred entirely in the dining hall, a one-story building, with three big doors opening to the ground level and with large unbarred and unobstructed windows extending all around. This structure was one of a group of buildings isolated from the main structure of the institution. This building, as were others in isolated groups, was fully equipped with water mains and with fire extinguishers. There was no hazard from heat. All wiring was in conduit. The building apparently presented a maximum degree of safety.

* * * * *

The Polyglot Poster. The N. F. P. A. has members in Calcutta, Helsingfors, Sao Paulo, Shanghai, Suva, Weltevreden and many other places where the language spoken is other than English. Strange as it may seem, it was not to these that the twenty-two tongued "No Smoking" poster mailed with the December News Letter made its greatest appeal, but to members in the United States and Canada. Letters received by the Executive Office show a surprising familiarity with some of the strange languages. This indicates an erudition altogether unsuspected among busy Americans. Perhaps one may infer that some of the good old Anglo-Saxon names appearing in the Year Book, which have previously been taken at their face value as indicating direct descent from early English nobility, may have originated in court orders similar to that changing the name of Mr. H. Kabotchnick of Philadelphia to Cabot, which change was recently unsuccessfully opposed by the Boston Cabots.

Perhaps the extension of the Cabot name to the Kabotchnicks of Philadelphia may be typical of the extension of Culture, so long regarded as residing exclusively in Boston, to pagan cities such as Chicago. One letter from Chicago commenting on the poster criticises the Assyrian, saying that it should be written in cuneiform characters, that it is a dead language anyway, and that it is probably Arabic incorrectly labelled. Boston, however, still retains enough esoteric learning to reply that Assyrian is a living language, written correctly in Chaldean characters, and spoken today by some 300,000 people.

* * * * *

The Berkeley Conflagration. The Berkeley, California, fire of September 17, 1923, was but a repetition of past conflagrations. The wooden shingle roof was again the chief offender. A high wind and deficient water supplies were the accessories. Were it not that

the lessons of the shingle roof fire must be almost indefinitely reiterated if they are ever to be really heeded we might be tempted to repeat what we said of the Bangor fire in 1911; that it was simply another shingle roof conflagration for a detailed description of which we did not wish to use valuable space in the QUARTERLY.

After every impressive shingle roof conflagration in history there has been a small local wave of legislation for fire safe roofs. Practically the only places having anti-shingle roof legislation are those which have been visited by disastrous fires, or those in the immediate vicinity of shingle roof conflagrations. The succession of four serious shingle roof conflagrations in 1916 and 1917, when Paris, Texas, Nashville, Tenn., Augusta and Atlanta, Ga., were all visited by serious fires within a period of two years, stimulated legislation for fire safe roofs for a short time, but during the lapse of six years during which there has been no major shingle roof conflagration the interest in such legislation has waned.

The striking lessons of the Berkeley conflagration seem to be having no appreciable effect outside of the immediate vicinity of the fire. A comprehensive roofing ordinance was enacted by the city of Berkeley a month after the conflagration; locking the barn door after the horse has been stolen, as is usual in such cases, but a valuable measure nevertheless. Now an effort is being made to unlock the door again—a referendum is being initiated to annul the part of the ordinance prohibiting the use of wooden shingles. It would seem that the people of Berkeley should be so thoroughly convinced of the culpability of the shingle roof as a conflagration spreader that public opinion would have no patience with the efforts of the lumber interests to repeal the recently enacted roofing requirements.

* * * * *

The Crime of the Criminal Court Building.

Criminal negligence is the only characterization that can be given to the conditions in the Cook County Criminal Court Building, Chicago, as described by John Plant in the article on page 229 of this QUARTERLY. This is not an exceptional case, the conditions found in this structure are typical of those in hundreds of other public buildings in the United States and Canada today. It is difficult to say anything strong enough to express our opinion of the indifference which makes such conditions possible, but the comments of "Fire," the official magazine of the Chicago Fire Department, should be endorsed by all N. F. P. A. members. Quoting from the editorial in "Fire":

> A few days ago the Chicago Fire Department found that the Cook County Criminal Courts Building was one of the worst death traps imaginable. Fire escapes are so rotten that they would collapse under the weight of ordinary usage, vertical openings, rubbish and an ammonia plant in the basement make

the conditions such as would bring joy to the heart of any first-class fire-bug. And to add to all this, hundreds of persons crowd the many court rooms every day. Many of them are women and children compelled by law to appear as witnesses, etc., and risk their lives in this death trap.

If this building were privately owned and the owner attempted to use it as a place of public assemblage, as it is used at present, he would be arrested. "Fire" actually doubts the right of the courts to make any person endanger his or her life by appearing in this building under the present conditions.

"Fire" would like to see the national fire prevention organizations go into court and determine if the compulsory education laws can make a child go to school in a death trap, or the right of the courts to commit an insane patient to an asylum that is operated in violation of all laws of safety, or the right of a court to compel by legal process the attendance of any person in a court room where his or her life may be in peril of flames.

Then when the public officials of the nation, states and cities are impressed with the necessity for obeying the laws made to safeguard the lives of our citizens and our children, it will not be so difficult to enforce the same laws against the individual.

* * * * *

The Pekin Dust Explosion. First reports of the starch dust explosion in Pekin, Ill., on January 3, have reached the Executive Office just before this QUARTERLY goes to press. The loss of thirty-five or more lives in the explosion and ensuing fire again shows the tremendous destructive power that resides in apparently harmless dust. This holocaust, because of the number of lives lost at one time, should arouse more than the ordinary amount of interest, and may be of influence in promoting public education on the fire and explosion hazard of inflammable dusts.

The N. F. P. A. Committee on Dust Explosion Hazards has for some time been at work on the preparation of regulations for the prevention of starch dust explosions, which if observed should eliminate the possibility of explosions such as that at Pekin. This explosion will give added impetus to the work of this important committee, whose constant hope is that their work can be completed and applied before the already long list of dust explosion disasters is still further extended.

* * * * *

Christmas Fires. Long years of preaching about Christmas hazards have not been in vain if we may take the 1923 season as a criterion. While this QUARTERLY goes to press too soon after Christmas for the N. F. P. A. Department of Fire Record to have received reports on Christmas fires through its regular channels, the number of these fires reported by the newspapers seems to be much smaller this season than in previous years. This may be explained by the more general use of electric lights instead of candles on trees and perhaps by a gradually developing appreciation of the danger of that most obvious of all fire hazards, the open flame near inflammable material. It is the unsuspected fire hazard that has the most dangerous possibilities; once the

danger is realized by the public more than half the battle is won. Beacon Hill, Boston, was illuminated on Christmas eve by thousands of window candles, which in many of the windows were within a few inches of light draperies. For every candle there were probably a dozen watchers, inside and out. No fires were reported on Beacon Hill that evening. This may have been merely good luck, but the inference is that no fires started because a substantial number of those watchers realized the danger and did not neglect a single candle.

A less obvious hazard, that of the electrical toy, continues to make trouble during the holiday season. This year the electrical toy train has been the principal offender. In Wollaston, Mass., an electrical train, overheated by long continued operation, ran off its track against draperies which ignited but were fortunately pulled down and the fire extinguished before the fire department arrived. In Buffalo the unusual combination of a sparking electrical train, cotton snow, a fresh oil painting, and an automatic fire alarm system that did not operate, resulted in a $750 loss in the show window of a department store.

* * * * *

Strikes by Volunteer Firemen. Within the past month Berwick, Pa., and Fairfield, Conn., volunteer firemen have, according to press reports, refused to answer alarms because the compensation or financial support demanded has not been provided. It is always a question in such cases whether the blame lies with the firemen who wilfully let property burn because of some minor grievance or with those who are so short-sighted as not to provide proper compensation for the fire fighters. The real fault of course lies with the indifferent public that permits petty politics or personal bickerings to interfere with fire protection. If an occasional fire like those in Berwick and Fairfield is necessary to arouse local public opinion, the sacrifice to the Fire Demon may not be altogether in vain.

* * * * *

The Protection of Government Records. The recently published report of Secretary Hoover of the U. S. Department of Commerce again calls attention to the need of a building to adequately house the Department of Commerce and its records, especially the census records. Quoting the report referring to three buildings now used by the Department, "two of which are ancient structures, expensive to operate and unsafe for the employees who are compelled to work in them. The third is one of the temporary war structures, which will be condemned within a year or two as unfit for habitation. It is now being used by the Census and contains invaluable records dating back to the founding

of the Government which if destroyed could never be duplicated."

Another part of the same report refers to the fire in the Census building in 1921 during which a considerable proportion of the original records of the census of 1890 were destroyed. (See April, 1921, QUARTERLY for report of this fire.) The crying need for the protection of these vital records is apparent, but there seems to be no evidence of the likelihood of any adequate steps being taken in the near future to correct this condition.

He never will be missed
The careless camper who caused the forest fire

—*Whittlings*

1923 Fire Losses.

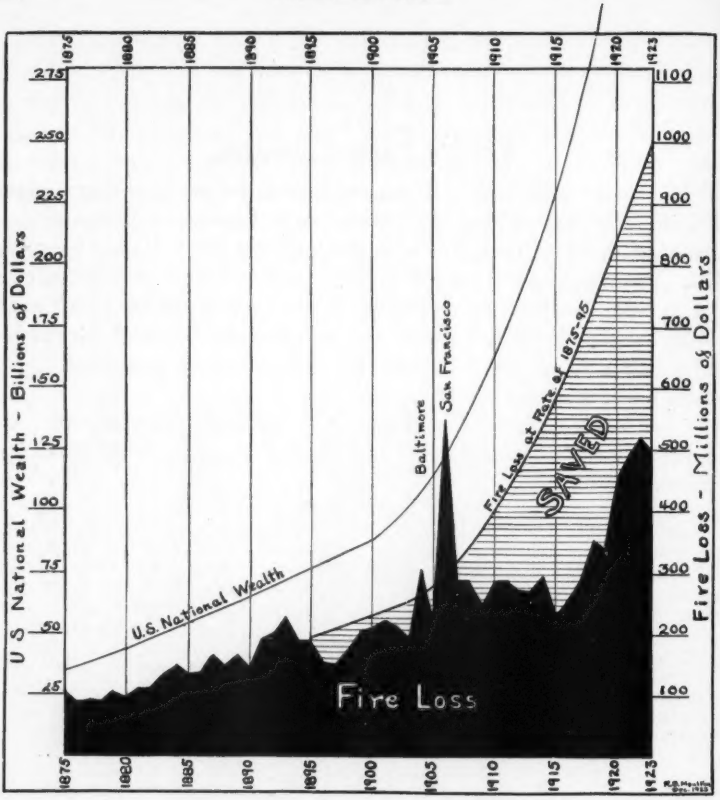
Fire losses in the United States and Canada for the first eleven months of 1923 are reported by the *New York Journal of Commerce* at $363,855,400. This compares with $363,463,350 for a similar period in 1922. December figures are not available as this issue of the QUARTERLY goes to press, but it seems reasonable to assume that the December losses will be less than in 1922, when the loss was exceptionally high for the last month in the year. On this basis the 1923 total may be several million dollars lower than that of 1922.

The following monthly table of fire losses is compiled from the records of the *New York Journal of Commerce* for the United States and Canada.

	1920	1921	1922	1923
January	$37,012,750	$35,319,950	$38,663,000	$36,614,850
February	26,631,500	25,888,850	29,304,300	42,770,800
March	27,597,701	28,581,100	39,910,750	41,159,650
April	22,108,750	22,178,900	31,009,750	32,638,150
May	25,440,300	23,956,800	29,868,950	34,015,850
June	25,745,900	29,000,700	24,102,850	34,851,900
July	25,135,825	33,355,750	36,667,750	27,490,750
August	17,930,800	25,829,000	21,579,500	24,474,300
September	25,630,050	26,502,400	41,515,000	28,738,500
October	28,331,100	27,955,350	40,065,400	31,398,450
November	28,093,350	26,178,600	30,776,100	29,702,200
December	41,197,600	28,907,550	47,426,000	.....
Totals	$330,855,626	$333,654,950	$410,889,350	$363,855,400

The Canadian fire losses for the first eleven months of 1923 totalled $32,314,300, as compared with $37,390,455 for the same period of 1922. The following table of Canadian losses is taken from the *Monetary Times* of Toronto.

	1920	1921	1922	1923
January	$2,637,850	$2,237,900	$3,597,500	$2,156,150
February	1,895,575	2,735,000	4,062,400	4,520,200
March	1,793,200	2,112,000	4,331,750	4,429,050
April	3,229,500	2,510,700	2,532,100	2,380,500
May	2,001,819	3,811,350	2,956,450	3,214,400
June	1,424,319	2,303,400	2,162,550	3,125,400
July	1,426,850	2,880,250	3,652,000	2,048,900
August	1,857,800	3,014,860	1,926,355	3,100,500
September	2,480,485	2,410,300	3,127,000	2,530,300
October	2,467,901	2,199,700	5,627,950	2,816,100
November	2,769,800	1,818,750	2,954,400	1,990,800
December	3,721,475	2,897,200	6,815,950	.....
Totals	$27,706,574	$30,932,110	$44,206,405	$32,314,300



These newspaper estimates are admittedly inaccurate, but nevertheless furnish a valuable basis of comparison. Prior to 1916, when the Actuarial Bureau of the National Board of Fire Underwriters was organized, the most satisfactory fire loss statistics available for the United States were those prepared from the *Journal of Commerce* estimates by subtracting the Canadian losses from the grand totals.

Since the organization of the Actuarial Bureau its more authentic figures have largely superseded those of the *Journal of Commerce,* though the time required for compilation of complete statistics by the Actuarial Bureau necessarily so delays the publication of these final figures that the *Journal of Commerce* estimates must be relied upon for data on each year's losses until such time as the Actuarial Bureau's final figures are published. On the average for the years when both sets of figures have been available, the Actuarial Bureau's totals have been about one-third larger than those of the *Journal of Commerce.* Estimating on this basis,

it may be predicted that final results will show that the 1923 total fire loss for the United States has been approximately $500,000,000.

While the total losses of recent years have been so enormous and have been increasing so rapidly that the results of fire prevention efforts have sometimes been questioned, the results seem much more hopeful if the fire losses be compared on the basis of national wealth, an obviously logical basis of comparison, instead of on an absolute basis.

The accompanying diagram has been prepared on a basis similar to that used by Member C. E. Worthington, as explained in the January, 1923, QUARTERLY, page 230. The solid black area shows the fire losses by years from 1875 to 1923. These are the figures of the Actuarial Bureau for 1916-1922; for 1875-1915 they are estimated from the *Journal of Commerce* statistics. The upper light line shows the national wealth as reported by the U. S. Census Bureau, extended by estimates for the years not covered by census reports. This diagram is but an approximation at best, being based, both as to fire losses and national wealth, on estimates which are admittedly more or less inaccurate. The general conclusions drawn, however, are obviously of such a character that they cannot be affected by slight errors in the basic data.

In the period 1875-1895 the fire loss had a fairly constant relation to national wealth, the curves are nearly parallel. After 1895 (N. F. P. A. organized 1896) the fire loss curve begins to fall away from the national wealth curve, although peaks are shown representing the Baltimore and San Francisco conflagrations in 1904 and 1906. The curve "Fire Loss at Rate of 1875-95," from 1895 to 1923, shows the fire losses which would be expected if the previous relation of fire loss to national wealth had been maintained. This shows that on this basis the 1923 fire loss would have been one billion dollars, just twice the actual estimated figure. The saving from 1895 to 1923, represented by the shaded area, amounts to a total of approximately $4,330,000,000. It cannot be denied that this four billion dollar saving, or at least a substantial part of it, is directly due to fire prevention efforts.

Fire Safety as a Credit Item.

By William Walker Orr.

Asst. Secretary, National Association of Credit Men.

If it is asked why the National Association of Credit Men takes part in fire prevention work, I answer that we do so not alone through a sense of good citizenship but because fire prevention work looks to that stabilizing of conditions which is essential to the safe extension of credits.

The interest of the organized credit men of the nation in fire prevention came about through a natural process. Within a year or two of the founding of the Association there was a spontaneous demand that we add to our regular committees one on fire insurance. The reasons given were that credits are extended on the strength not only of what a man is but what he has; that upon what he has fully as much as upon what he is depends the ability to liquidate obligations. It was shown that if what a man has is swept away by fire or other disaster, his creditors will find themselves in possession of promises to pay far less liquid than before. Upon the settlement of these obligations his creditors are likely to be asked to permit a discount small or great, unless the debtor had, voluntarily or under the demand of creditors, provided against disaster by entering into a contract with good and sufficient sureties to indemnify in case of property loss.

The relationship between credit and sound insurance needs little explanation. In most cases that debtor is unfair to his creditors, whose interest in his property may be greater in dollars than his own, if he, in the face of our enormous annual fire losses, takes the chance that his property is safe from all fire threat. And so, the credit man, individually and in his associations, has been urging or demanding, as circumstances suggest, that those to whom he extends credit insure adequately. Among the credit man's numerous duties is none more important day in and out than to see that the credit extensions he makes shall be as amply protected if the debtor's property is destroyed as they would be if the debtor's business continued undisturbed by disaster.

Debtors Complained of High Insurance Rates.

But the credit man found that he could not stop there. He found his customers complaining that insurance costs were too high to permit insuring adequately; that although they realized that inadequacy of insur-

ance threw the major chance on them and their creditors, yet there seemed no solution. It was discussions regarding situations like this that led the credit man to a consideration of the factors of rate making in insurance.

The studies of the credit man led him to the conclusion that the rate of burning is the factor of most importance in determining the insurance premium that shall be charged on various localities and in various lines. He found, too, a situation that would have been puzzling and surprising to the business mind of a few years ago, namely, that the insurance companies themselves were the biggest factors we had for the reduction of fire losses and that they were working almost without help from the general public.

When the National Association of Credit Men, through its proper committees, announced its purpose to attack rates at their source by employing methods of reducing fire losses, it undoubtedly helped much to turn the attention of the public from the premium rate itself to the elements which go to make up the rate. This was essential to any effective interest in the cause of fire prevention.

It was during the secretaryship of Charles E. Meek that the National Association of Credit Men entered into its effective fire prevention work. It was he who established between the National Association of Credit Men and the National Fire Protection Association, through Secretary Wentworth, a close alliance, as a result of which the N. F. P. A. achieved, I believe, a broader contact with the general public than it had previously enjoyed.

Why Fire Safety is a Credit Item.

Fire safety is a credit item in that through the reduction of fire we have the most effective method of reducing insurance rates. To the extent that rates are reduced we remove the excuse which applicants for credit again and again put up to credit men, namely, that the premium rates are so high that business cannot bear the burden of carrying adequate insurance.

Through the direct efforts of credit men's organizations in some of our important cities, methods have been installed which have resulted in so appreciable a reduction of the annual fire loss that the insurance companies have not only reduced the premium rates but felt it safe to extend their lines more freely in these cities.

Increasing Fire Safety and Improving Credits.

We find a situation in certain lines of business which has brought out in a most interesting way the relation between fire safety and credits. As we know, certain lines of business are extremely hazardous by the very nature of their operations and the materials handled. In some of these

$520,000,000
ANNUAL FIRE LOSS
NATIONAL FIRE PROTECTION ASS'N
AMERICAN CHAMBER OF COMMERCE
The girl is certainly in a bad position, but with the rescue squad coming up conditions are bound to improve.

hazardous lines there has been concerted action to reduce the hazards and bring the fire losses down to the lowest possible point.

The results, as we know, in the drug, cotton and flour industries have been astonishing. From being lines of great hazard, affecting adversely the welfare and prosperity of communities, these lines, whose processes are inherently dangerous, now present examples of solidity and stability scarcely excelled in any line. They have become not only attractive to insurance companies, which compete sharply for the business offered, but attractive to those controlling credits whether as investors, bankers or the commercial houses.

In these lines we no longer have, as formerly, examples of men and concerns burned out, their properties wasted and proprietors too discouraged to continue business. These lines are now stabilized and their credits are more easily established. As a result of greater safety from sudden fire waste, concerns in these lines need not make such large capital provision. They can safely operate on the more generous credit facilities readily obtained.

In the lines just cited, we find a contrast between the old and new conditions that reminds us of the contrast between banks operating under the old individual banking system and the same banks under the new Federal Reserve System. Before the Federal Reserve System was established, bank reserves had to be large,—banks had to hold large supplies of actual cash in hand at all times for protection against unexpected, untoward credit conditions. With the reserves of our banks, however, pooled in the Federal Reserve System, the actual cash holdings of each bank were safely reduced; reserves by law were made materially lower without increasing in the slightest degree the dangers incident to sudden changes in conditions. Indeed, the situation under the lower reserves, as we know, is far more stable and dependable than it was under the larger reserves of ten years ago.

Under the new system of reserves, credit can be extended with far greater freedom than under the old system because there is a sound basis for credits which did not before exist. Likewise, in the lines which have greatly reduced their fire hazards such as drugs, flour and cotton manufactures, there is presented a basis of credit extensions in all forms, such as under the old conditions did not exist.

Inasmuch as a sound credit is the most important possession of every business house,—it is amazing that we find so few concerns, or rather so few lines of business, that have recognized how great will be the contribution to their credit standing if they but imitate the examples found in the lines mentioned. Here is a subject of first importance in the discussions before our various trade organizations. The inherent hazards in some lines are much less than in others, but in all lines by close study and concerted action and a cultivation of the spirit of excellence in making each year better than the year before, hazards with all their accompanying losses can be reduced. The result is that standards of business in the line will be raised, large financial savings will be attained and credits will find in the line a more attractive field.

There are many other ways in which this subject of fire safety as a credit item could be treated. Let me refer to one more. Consider, for a moment, what the conflagration means to the man who handles credits. The engineers of the National Board of Fire Underwriters tell us that every American city and town has its conflagration hazard, that given a combination of circumstances in any city, a fire once started can hardly be controlled before a large section has been reduced to hideous smoking ruins. Any man with a reasonable equipment of observation and imagination will recognize the conflagration hazard of almost any community.

Fire Freezes Credits.

Depending upon its extent, a conflagration undoubtedly gives credit a real set-back. In the first place, the outstanding credits to those who suffer are inevitably tied up for an indefinite period. These credits to the stricken business people enter into that class of credits against which the credit man is ever fighting—that of frozen credits. The dire distress of the debtors and the human element in business leads the creditors to add to their frozen credits further credits if a merchant has had a good history, even though it is known that the new credits will be hardly less frozen than the old credits that were extended before the conflagration.

Furthermore, on the insurance companies' side we have a strain and stress on credits as a result of conflagration. The insurance companies must pay in cash the losses against which they have insured. The payments following conflagration run into immense figures amounting in the case of the San Francisco fire in 1906 to nearly $250,000,000.

The companies do not and could not keep such sums in cash for the payment of their losses. They have to re-adjust their entire financial program; they have to call upon their secondary reserves with the trust companies and their third line of reserves, carried in the form of less liquid assets, namely the securities of our railroads and industries which must be sold on the market in order to raise the necessary cash to meet their contracts with policy holders.

The feeling is general that the San Francisco conflagration of April 1906 contributed in large measure to the strain resulting in the panic of 1907.

Credit Feels the Big Annual Fire Loss.

The half billion dollar fire loss which is the pace of burning in America that we have now reached, is not without significance to the men who extend the credits of investment and commerce. It means the wiping out not of money or the symbols of money, but of actual wealth upon whose value, as measured by its availability in satisfying men's wants, vast credits are extended. The fact that we replace this wealth quickly with other goods purchased, it may be with money received from insurance, gives the false notion that no real loss has been sustained. Insurance money cannot restore property that has been destroyed. Through it substitutes may be obtained, but that is all. The wealth and the basis of credit in the larger sense are gone so far as the world at large is concerned. We should find ways of getting this fundamental thought home to the people. Until we do, the fire waste problem cannot be understood.

Let me quote two passages in the report of the Fire Insurance and Prevention Committee of the National Association of Credit Men to the annual convention held at Atlanta, June, 1923:

> Throughout the work of the credit man runs the purpose of measuring the character and capacity of men. Credit men are finding that a customer's interest in fire insurance and prevention presents a rather accurate test of the man, helping to determine whether he is inclined to take unnecessary chances, whether he has foresight against eventualities or recognizes also that his property must be thought of in a sense as held in trust so long as creditors share with him an interest in the property.
>
> There is, moreover, no body of men in better position than credit men to exert pressure to force business men to give attention to methods of fire prevention so that they shall see that it is not enough for them to insure their property, but equally important to operate in such manner that the chance of fire shall be minimized.

These passages present rather clearly the fact that credit men are seeing a very clear relationship between fire safety and credit. The passages apply, of course, to the advance guard of the credit men's profession,

but the numbers of those who recognize fire safety as a credit item are steadily growing.

Let me add another brief paragraph from the same report:

> The problem of fire reduction will not find its real answer in legislation, but in the heart of the people whose personal sense of responsibility must be stirred by the exercise of all those forces which make for the building of decent public opinion.

This paragraph and its context refer to the incendiary fire, the fire that has come to be known as "distress fire" that characterizes deflation periods. It has too long been the custom to appraise lightly the offense of burning one's property for the purpose of turning it quickly into cash. We look upon the offense lightly though as owners of property we contribute to the insurance fund against which the incendiary or distress fire maker directs an assault that defies every law of decent sport.

The public conscience must be aroused against this sort of thing so that the courts and juries shall find it less difficult to carry through a successful prosecution.

I have tried to indicate that the credit man has a most vital interest in fire prevention. The National Association of Credit Men has shown itself eager to form a close alliance with every force in the country fighting for a reduction of fire loss, for credit men are convinced that fire reduction looks progressively toward the stabilizing of credits.

The New Architecture.*

By Henry S. Churchill.

The New Architecture is with us, inexorably forced upon us, whether we will or not, by economic law. The relentless drive of economic necessity, the governing law of modern, even if not, as some maintain, of all life has created and is creating the architecture of today in actual structural fact. Aesthetically, where that law has been accepted and expressed, we have a living art; where it has been denied and disguised, we have a dying art.

Architecture has always been a reflection of the age that produced it. The hope of Egypt, the clarity of Greece, the pomp of Rome, the faith of the Middle Ages, the license of the eighteenth century, the acquisitiveness of the twentieth are faithfully mirrored in the temples of the times, whether these temples be of Ammon or of Mammon. Nor is there any doubt that as the material side of life has developed more swiftly in the last hundred years than in all the preceding historic centuries, so the structural side of architecture, which corresponds to the material side of life, has undergone greater changes in the last generation than in any preceding period of its history.

A hundred years ago New York was a charming, if muddy, city of red-brick houses with white doorways and cast-iron balconies, spired churches, and low warehouses and wharves, situated on a rocky island. Farm-houses dotted the open spaces between the villages of Yorktown and Harlem, Manhattanville and Bloomingdale. The fateful shadow of the gridiron had not yet fallen across it. As population, wealth, and ostentation increased, there came brown-stone fronts in endless rows, and more and more massive office buildings. In 1880 the first elevated railroad trailed its blighting way out to Harlem, elongating the city, choking its cross-town expansion, relegating the river fronts, the city's natural outlets to air and beauty, to commerce and squalor. Land in the Battery section became immensely valuable. Investors and owners, endeavoring to squeeze every drop of increment from their land, found that by building higher they could get greater returns. The height limit, however, would have remained that of convenient walking had it not been for the invention of

* Reprinted from *The Nation.*

the elevator. With its advent vertical transportation became a reality and the skyscraper a possibility.*

But limitations to the first high elevator buildings were soon discovered. It was found that the increase in thickness of the bearing walls necessary to carry great height ate up rentable floor space too rapidly to make a very great number of stories profitable, and besides cut off too much light. To take the place of these clumsy walls, cast-iron columns came into use, and various systems of long-span fire-proof floor construction. These were gradually developed to relieve the walls of practically all weight but their own. As the steel industry developed, steel columns came into use on account of their greater strength. The steel shapes were slowly standardized for lightness, convenience of design, and most of all swiftness of erection. It was found that by riveting an angle to the wall-beams it was possible to erect masonry from floor to floor independently of a masonry base, or to start it on many floors at once. The self-supporting wall thus went out of existence, as the floor-bearing wall had gone before, and the true skeleton frame came into being. Walls became simple fillers between floors, without any structural value whatever. This permitted reducing them to the least thickness compatible with their staying in place and keeping the weather out, and not only saved space, but weight and, consequently, steel.

Just as steel frames and curtain walls came into being through economic reasons, so brick has largely replaced stone as the material for those walls. Stone walls on a skyscraper are an anomaly. They do not carry themselves; they must be backed by some material to be weatherproof; they must be deviously anchored. In our industrial cities they deteriorate in the gas-laden atmosphere. The use of stone is an aesthetic tradition; the monumental material of the past, its use was appropriate in wall-bearing construction for monumental and sumptuous edifices. Today it persists as an example of the theory of conspicuous waste.

That stone has so largely gone out of use in recent years except for trimmings is due, however, not to a realization of its essential unfitness for its purpose, but to prohibitive cost occasioned by a combination of circumstances chiefly arising from the war and trade-union regulations. Under the pressure of these conditions, and not from any aesthetic choice, it was discovered that brick could be beautifully laid in patterns as a colorful and decorative surface instead of as an imitation masonry wall. And the logical successor to brick—especially if the brick manufacturers succeed in combining themselves out of business—is terra-cotta.

* The first real skyscraper was erected in Chicago, but under analogous conditions. There high property values were artificially created by the elevated "loop," which still effectively strangles the city.

Another change, the most recent and obvious, in the architecture of New York, has been brought about by the zoning and set-back laws. Economic dictates, of course, were behind the enactment of these laws. When the greed of property owners and speculators in exploiting the space above their lots threatened not only to become a menace to public health but to reduce rentals by cutting off light and air, it was found desirable to limit an owner's rights to do what he pleased with his own. The Rights of Private Property were invaded ostensibly for the protection of the public—and one of the most beautiful and characteristic effects of New York architecture has been the result.

With the practical modern office-building essentially a steel frame requiring, logically, an entirely new exterior expression, a fair question is: Why are our streets lined with specters of the outworn past? In a measure it is because aesthetic development must always lag behind structural changes which demand such rapid visual readjustments as are involved in the change from wall-bearing to skeleton steel construction.

A generation is a short time for the eye to get accustomed to new dynamic relationships. One of the most important of these relationships is the immensely greater strength of steel as compared to the materials formerly in use. The experience of ages had taught that so much masonry was needed to support so much weight; that a stone could reasonably span such a distance, a wood beam such another distance; that too slender a support would buckle and break, too long a lintel sag and crack. Steel and reinforced concrete have changed all those long-accustomed balances. The eye must come to new realizations of what is safe, and therefore what is comfortable, and therefore what can give pleasure.

Other changes are the elimination of shadow brought about by shallow reveals in the thin curtain-walls, and the consequent emphasis of surface as opposed to mass; and the tremendously increased importance of the silhouette under the application of the set-back laws.

These adjustments are gradually taking place. The trend of the new design may be briefly and cursorily traced by considering the Park Avenue Hotel, the World Building, the Waldorf-Astoria Hotel, any loft building in the Fifth Avenue twenties, the Plaza Hotel, the Woolworth Building, Pierre's and Sherry's, the Fisk Building, and the new Shelton Hotel on Lexington Avenue.

It should be noted that while economic pressure tends on the one hand to make buildings structurally modern, on the other it tends to hold back aesthetic progress through fear that "novelty" in appearance may hinder rentability. It is for this reason, as well as for aesthetic ones, that so many of our commercial structures are clothed in ill-fitting garments.

Although there is slow but evident progress visible in our commercial work it is nowhere visible in our public edifices, where the question of expense is not so fundamental, the desire for conspicuous waste often a ruling motive, and the dead hand of academic tradition falls most heavily. With the exception of the design for the Nebraska State Capitol, none of our recent public buildings show the slightest attempt to develop an architectural expression in accord with either the structural system or their surrounding civilization. Their steel frames are swathed in mummy-cloths. The absurdity of steel-framed masonry domes! The sterility of rows of useless columns! Endless modillions and garlands taking the place of imagination and suitable invention! How can they be other than ostentatious, dreary, and monotonous?

Almost as little evidence of change is to be found in our domestic architecture. Characteristically enough, the more expensive the work, the more time expended upon it, the less the progress. The reason here is not only the comparative lack of economic pressure; there is a simple psychologic factor involved. A man's house is what he lives with, and to most men the most usual is the most livable. Anything "different" in the way of a home would make him feel as ill at ease as a purple shirt with lace ruffles. Then, too, the rich man sees a villa or a palace abroad, and because it costs more to build, and looks it, he must have it reproduced here—the Palazzo Massimi on Fifth Avenue, a Tudor mansion on Long Island, a Brittany farm-house in Westchester. Of course structural methods in the domestic field have not changed so radically as they have in larger building; it is not, perhaps, so heinous an offense to build a modern brick house in imitation of an old one. However that may be, our most living—if not livable!—domestic work is to be found in the model-housing industrial villages, where rigorous elimination of waste and the need for quantity production have prevented the aping of a long-dead craftsmanship, and simple, good effects have had to be obtained by the use of machine-materials, "untouched by human hand." In the same way, the noticeable increase in restraint and "good taste" in the speculatively built apartments in New York, which has received favorable comment in many quarters, has not been at all due to an increase in good taste, but to the prohibitive cost of gimcrackery.

Economic forces will thus in time bring about a new architecture aesthetically, as they have already done structurally, replacing mass and shadow by surface and silhouette. Proportion, the basic factor of good design, will always remain the chief factor. However, good proportion and its concomitant, good "scale," are not absolute, as the academicians like to think, but depend on inter-related relationships—the size and shape

of the building, the relation of its many parts to the human figure and human needs, the materials used, and the system of construction. Good classic, gothic, and steel proportions are very different things, although many architects seem to think they are interchangeable. A rhinoceros skin does not fit a giraffe, nor even a cow, though all are mammals.

When modern structural methods are followed out to their logical conclusion, the results are progressive and interesting architecture. When eclectic aestheticism is followed, when "art" is the inspiration, the result is only pretense and puerile copying. Only from a building which answers inevitably to our modern needs do we get a modern emotion, a feeling of hardness, steel, vibration, discordant beauty, an emotion satisfying to our modern spirit. It is not beauty as the Greeks understood beauty, nor emotion as the builders of Chartres understood emotion, but it is life as it is understood today.

We need fewer artists and more architects; less art and more architecture. When we finally get that, we shall not need to look either humbly or reverently toward Athens, Rome, or Paris.

Converted Fire Boats.

By A. M. Schoen.
(Member N. F. P. A.)

During the period of the war after the United States government had taken over the railroads of the country, following the government's practice with reference to all properties owned or controlled by it, all fire insurance policies were cancelled and the contingent liability assumed by the federal treasury. Among these widely scattered properties the heaviest values were to be found at the various port terminals, these sometimes reaching, with the contents, to figures in excess of $75,000,000 at a single location and all subject to one fire. In such places the conflagration hazard was often very severe, especially at those cities not equipped with fire boats for fighting a blaze from the water side. Fortunately, during the time of active hostilities while men and munitions were being rushed to the front, no fire of serious proportions occurred at these points, due no doubt to the intense activity of the authorities along the line of fire preventive measures and the elimination to a large extent of the habitual carelessness of the American people as concerns fires.

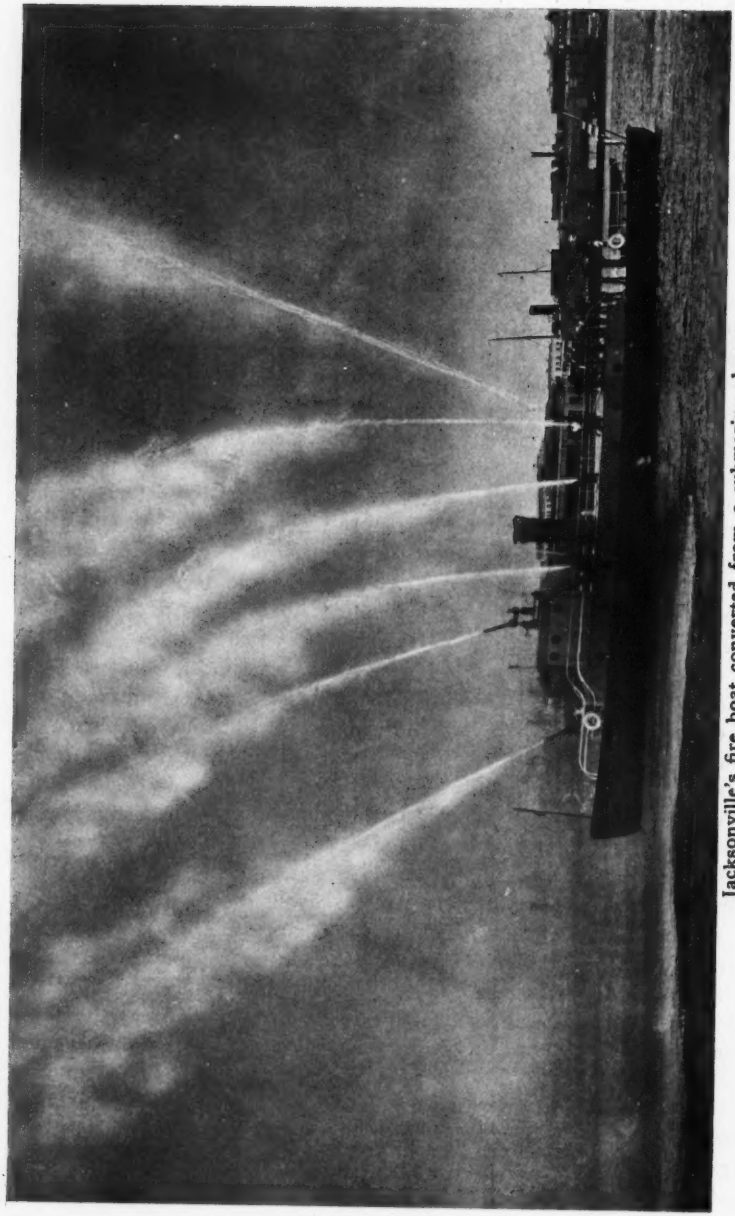
Following the signing of the armistice, however, the high pressure under which the nation had been living and doing business ceased and a

gradual dropping back to the old habits of life was to have been expected. While the record continued comparatively good as a whole, soon more or less serious losses began to occur and the loss of the Seaboard Air Line's Hutchinson Island Terminals opposite Savannah, while not so severe as might have occurred at many of the other properties under lease and operation by the Administration (the loss reaching somewhat less than $1,000,000), yet served to demonstrate what might be expected in such places where fire boat protection was not available.

In casting about for some means of providing, at minimum expense, the necessary equipment for fighting fires from the water side of properties, the Administration's Fire Loss and Protection Bureau turned its attention to the floating equipment originally constructed for war purposes, which at the cessation of hostilities ceased to be needed and merely served to clutter up the harbors. A survey of this field led the Bureau to the conclusion, all things considered, that the best results for the intended service could be accomplished through converting and manning some of the abandoned submarine chasers. The determination to use these craft was based largely on (1) the comparatively small cost of converting them; (2) the fact of their being comparatively light and fast and using internal combustion engines, thus allowing them to be manned by a minimum crew; and (3) the light draft enabling them to manoeuver in fairly shallow water and thus approach within fire stream distance of properties that would be out of reach of craft having greater draft.

The subject was taken up with the Navy Department, whose endorsement and co-operation was promptly obtained. This department of the government furnished the Railroad Administration with full data concerning the construction of the submarine chasers, as well as a list of those available and a statement of their condition and the yards where they were constructed. It also assisted in the preparation of plans and specifications for their conversion to fire boats.

About the time this initial work was completed and estimates of costs obtained, the government reached a definite decision as to the date on which the roads were to be turned back to their original owners and naturally lost all interest in further expenditure for improvements or protection, so it was useless for the Fire Loss and Protection Bureau to pursue this subject further. However, some of the growing port cities, especially in the southeast, had become interested and the information gained and the data worked up was made available to them. A number of cities along the Atlantic seaboard and the Gulf of Mexico went into the matter more or less fully, with the result that Jacksonville, Florida, converted a submarine chaser, and Norfolk, Virginia, converted one of the steel tugs obtained from the Quartermaster's Department, the government



Jacksonville's fire boat converted from a submarine chaser.

allowing the boats to go to these cities at figures so small as to be practically negligible and thus enabling otherwise practically waste material to be used for the public weal instead of leaving it to decay and rust as was done with so much other war equipment.

Jacksonville's Boat, the "Callahan."

Work on this boat, one of the submarine chasers which had been lying at Key West, Florida, was begun in the spring of 1922 and she was completed and put into commission in September of the same year. This boat is 110 feet over all, 15-foot beam and 6-foot draft, triple screw, and equipped with three 6-cylinder standard marine gasoline engines of 220 horse-power each and operating at a speed of 460 r.p.m. Under service this boat has a speed of 16.8 knots with all three engines turning and 14 knots with two, which speed was slightly increased above 14 knots with the center screw removed. When the boat reached Jacksonville and was put on the ways, it was found to have been badly damaged by the teredos and many of the timbers had to be replaced. Two of the bulkheads were removed and considerable steel reinforcement was built into the hull, while the wood pilot house and other superstructure was torn away and replaced with steel, though the wood hull and deck were retained. Below decks space was obtained for a large engine and pump room, the machinery after installation being left unusually free of congestion. The entire driving and pumping equipment was located in this one room, thus providing reliable operation with a minimum number of men. For driving and manoeuvering the craft the two original wing engines were completely overhauled and put back on their original beds, the center engine with the propellor being removed, primarily to obtain the needed space. These engines are entirely independent of the pumping equipment, which latter consists of four 8-cylinder 300 horse-power gasoline engines operated at 1800 r.p.m. and each direct connected to a three-stage centrifugal pump of 1250 g.p.m. capacity at 150 pounds, or 1000 gallons at 250 pounds. These engines are equipped with storage battery and compressed air starters. Water is taken through four suction pipes and is fed through a header to monitor nozzles and "niggerheads" for hose connections, the arrangement of the valves on both suction and delivery providing thorough flexibility under which any desired combination of pumps, suction and delivery may be obtained, thus securing a maximum liabilty factor. The deck equipment consists of three turret nozzles, one forward, one aft and one mounted on the roof of the pilot house, 3000 feet of 3-inch hose in a bin abaft the pilot house, and "niggerheads" at the base of the forward and aft turrets, each having three 2½-in. and three 3-in. outlets. Below decks, just abaft the engine room and cut off therefrom by a gas-tight

Norfolk's new fire boat converted from a Navy tug.

bulkhead, three all copper gasoline tanks are located, each having capacity of 400 gallons. These tanks are so arranged, both as to settings and locations, as to minimize the likelihood under the most extreme conditions of any escaping gas reaching any other part of the boat. The funnel shown in the illustration was left for the purpose of ventilation.

Upon completion of the work of conversion, the "Callahan" was given an official test, both as to her manoeuvering ability and the operation of her pumping equipment. Lying in her slip, nose pointed toward the channel, crew at quarters but with all machinery at rest, at the signal the self-starters were thrown, the engines turned over and the boat moved promptly forward, reaching the center of the channel, turning at right angle down stream and going full speed ahead in exactly 60 seconds from the time of the signal. The time consumed in changing from full speed ahead to full speed astern was 47 seconds. At full speed this boat will make 13 miles per hour. Under test the pumps showed an average delivery of 1567 gal. per min. each at an average pressure of 152 pounds and 1032 gallons at 252 pounds.

The cost of the boat equipped and ready for service was approximately $65,000, and it may be here remarked that during the period she has been in commission, some fourteen months, she has already saved in property values along the Jacksonville water front more than six times her original total cost and bids fair to prove one of the most valuable arms of the Jacksonville department.

Norfolk's Boat, the "Vulcan."

The city of Norfolk, with its magnificent harbor and largest water front values of any southern city, first considered converting a submarine chaser for her needs but finally decided on one of the steel tugs from the Quartermaster Department, preferring this to a wooden hull. The boat selected has overall dimension of 104 feet, 22-foot beam with draft of about nine feet. The driving equipment consists of a 450 horse-power Scotch marine boiler and a triple expansion 350 horse-power marine engine. Her speed is 10.35 miles per hour. The pumping equipment consists of four three-stage centrifugal pumps, rated capacity 1400 g.p.m. at 125 pounds pressure, each direct connected to a 6-cylinder marine type gasoline engine of 225 horse-power, operated at 1350 to 1500 r.p.m. The pumping equipment is housed below decks in a space on the same level with and forward of the engine room, cut off by a bulkhead, and the two copper gasoline tanks, of 500 gallons capacity each, are housed just forward of the pump room, thoroughly protected and cut off by a gas-tight bulkhead. The gasoline engines have duplicate ignition and storage battery starters. The pumps take water from the river through four suction pipes flexibly arranged as to the pumps supplied and each pair of pumps feeds to a single header with the arrangement of valves such that those on either side of the boat may be operated either in parallel or tandem. The fire fighting equipment on deck consists of four turret nozzles, one forward, one on a tower erected above the roof of the pilot house, and the other two on the after deck. The two after turrets have "niggerheads" of twelve 3-in. hose outlets each, in the base of each standard, and instead of carrying a full complement of deck hose, an automobile tender carrying 3000 feet of 3-in. hose follows the boat along the shore. The complement of hose carried by the boat consists of 2000 feet of 2½-in. and 3000 feet of 3-in.

This boat was completed and pronounced ready for official test in April, 1923. Under test the four pumps showed an average of 1402 gal. per min. each at an average pressure of 128.8 pounds, and 702 gal. per min. at 251 pounds.

Up to the present time the "Vulcan" has not had opportunity to play an important part in any severe fires, though she has helped prevent the spread of some waterfront fires that might otherwise have reached serious proportions. Chief Petty of the Norfolk Department and Major Borland, the City's Director of Public Safety, feel thoroughly satisfied with her ability to perform satisfactorily when the time arrives. The cost of the boat was about the same as Jacksonville's.

The Dunning Insane Asylum Holocaust*

A fire which occurred during the evening of December 26, 1923, in a group of joisted frame buildings, part of the Illinois State Hospital for the Insane at Dunning (just outside of Chicago), caused the death of eighteen persons. This fire, like so many others of the disastrous institutional fires that have occurred in the United States and Canada, was due to extremely hazardous conditions which should never have been tolerated.

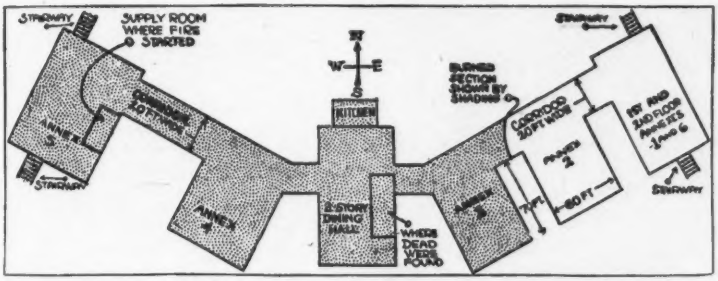
Construction.

The scene of the fire was a group of six one and two-story frame buildings communicating through one-story frame passages 30 to 50 feet long. The general arrangement of the buildings is shown in the accompanying diagram. The central building was occupied as a dining room on the first floor and a dormitory above. The area was approximately 5,500 square feet. There was a two foot unused space under the lower floor. Floors were double one inch boards on ordinary joists. The walls and ceilings were wood sheathed. The roof was prepared roofing on one inch boards on ordinary joist and wood truss. Annexes 3, 4 and 5, which were destroyed, were one-story structures similar in construction to the dining hall portion and covering an aggregate area of approximately 10,000 square feet. The passageways were one-story frame with an approximate area of 6,200 square feet. The annexes were used for dormitories. Each dormitory was provided with wood bins in which the patients' clothes were stored and small enclosures in which mops, brooms and cleaning materials were kept.

Occupancy and Hazards.

The buildings contained about 300 patients, mostly epileptic, but some violently insane kept on the second floor over the dining room. Many of the patients had received Christmas cigars and cigarettes and they were allowed to smoke in the buildings without restriction. The mop closets in each dormitory contained polishing mops made of six inch pipe wrapped with discarded bed linen and blankets. Paraffine wax was rubbed on these mops, which were used for polishing the floors. The buildings were heated by steam, the radiators being covered with wire mesh and sheet metal guards.

* Information furnished by The Chicago Board of Underwriters (member N. F. P. A.)



Plan of the buildings involved in the Dunning Insane Asylum fire.

Protection.

A private hose reel with 300 feet of hose was kept in a frame shed located within 150 feet of where the fire started. Three four inch hydrants with six inch mains were supplied through eight inch and ten inch mains from two steam pumps at a power house taking suction through an eight inch connection to city mains. A city hydrant was approximately 300 yards distant. The nearest city engine company was 3½ miles away. No watch service was maintained. A few 2½ gallon soda-acid extinguishers were provided.

Story of the Fire.

The fire was discovered at 5:40 P. M., when all the patients were at supper in the dining room, by a patient who habitually stayed behind to say prayers. It started in the mop closet in Annex No. 5. The cause has not been definitely established but it is probable that spontaneous ignition of the mops or defective electric wiring was responsible. The patient immediately shouted "fire" and a nurse in the dining room telephoned to the operator in the Administration Building, who sent the alarm to the power house where a siren was sounded. A city fire alarm box located in front of the Administration Building was pulled at 5:41 P. M. The fire spread rapidly and the patients in the dining room were hustled out of the building and lined up outside. There were only eighteen guards to handle the patients, some of whom were violently insane and all of whom were panic stricken. The doors of the dining hall opened inward, creating a jam, and the lights went out, adding to the confusion. A number of the patients eluded the guards and ran back into the building to save personal belongings. Most of these burned to death. A caretaker and his wife, who had rooms on the second floor over the dining room, went back to get their eight-year-old son. They remained to pack up some belongings and all three perished.

The guards marched the patients to the Administration Building. On the way the violently insane patients bolted and many escaped into the

Digging for bodies in the ruins.

city. Three men broke out of the line and ran back into the building and locked themselves into a lavatory on the second floor. Policemen entered and broke down the door and were able to force the patients down ladders to safety.

The private fire brigade had a fairly good hose stream playing on the fire when the city department arrived, but the buildings were all aflame and some walls were already falling. The battalion chief turned in a "4-11" alarm on arrival at 5:56 P. M. The wind had been blowing from the southwest and sweeping flames directly toward the other wards, but fortunately at this time it shifted and the firemen were able to save annex buildings one and two. Seven engine companies and four truck companies responded to the fire. The roads had been transformed to deep mud on account of a heavy rain and great difficulty was experienced in moving the apparatus. Fourteen bodies were found in an area of approximately 300 square feet at the rear of the dining room.

The Cook County Criminal Court Building.

By John Plant (Member N. F. P. A.)

Chief Engineer, Bureau of Fire Prevention, Chicago Fire Department.

The Cook County Criminal Court Building, Chicago, is a seven-story and basement building, 110 feet high in the center, or corridor section, and the east and west sections, used as court rooms, are six-story and basement, or 100 feet high.

The building has a main corridor in which the passenger elevators are located, and also iron stairs. These stairs and elevators are open and would permit smoke and gas to spread from floor to floor.

In both the east and west sections are open elevator shafts for taking prisoners from the second floor to the upper floors. These elevators have ordinary wooden doors and frames, and in case of a fire starting in the basement would prove to be chimneys conveying fire and smoke to the upper floors and would become veritable roaring furnaces in a few seconds' time.

Then, too, immediately next to the toilet rooms and janitors' quarters, in both east and west sections, air shafts extend from the basement to the pent houses on the roof. The windows in these air shafts leading to the toilet rooms, janitors' closets and fire hose cabinet rooms, as well as to other interior rooms, have ordinary wooden frames and plain glass.

What do these facts mean with regard to fire control and fire extinguishment?

It means that a fire starting in the basement, or on the lower floors, will spread to the unprotected air and elevator shafts with a rapidity that cannot be comprehended by the layman. Smoke, gases and heat will fill the upper floors so heavily that the main corridor and elevator shafts cannot be used. Panic conditions will prevail.

Old Corncob Pipes in the Switchboards.

Why a fire has not occurred in this building seems strange. The setting is as perfect as if it were intended for a quick and rapidly spreading fire. The rubbish conditions in the fire hose cabinets on all floors are abominable; old burlap bags filled with waste paper, rags, old clothing and junk of all descriptions. Old corncob pipes and old newspapers are stuck behind the electric wires and in the switchboard cabinets. When it is

NOTE:—Editorial comments on this article will be found on page 203.—ED.

called to mind that 90 per cent of all fires originate from rubbish accumulations in basements, attics and out-of-the-way places, one wonders why a fire has not occurred in one of the rooms.

Located on the balcony floor just east of the main corridor is a room called, I believe, a "catch-all-room." This room is impossible; a criminal accumulation of old lumber, old paper, burlap bags filled with old paper, etc., besides old furniture and junk. This room has openings through windows with wooden sash and plain glass, to the air shaft. There is enough combustible material in this room to start a fire that would gut the whole building. Should this fire start while courts are in session, I shrink from its possibilities.

The storage of waste paper in the custodian's supply rooms, which have openings into the vertical west air shaft, is a great thing, provided the destruction of the building is desired!

Decomposed Fire Escapes.

There is not a "Fire Escape" or "Exit" sign in the entire building. The windows leading to the fire escape have, in every case, sills four feet above the floor. This is quite a height even for an active man, and to expect the average person, especially women, to reach these window sills is most unreasonable. A Chicago city ordinance states that where a fire escape window is over 24 inches from the floor, steps must be provided leading to the window. The two fire escapes, one on the Dearborn Street side and the other on the west, or alley side, are in such an advanced state of decomposition that I hesitate to recommend scraping and painting.

It is almost impossible to believe that fire escapes on this building would be permitted to reach such an advanced state of decay. These fire escapes would not be tolerated over night on a private building. The stair treads are warped and arched so badly that it is hazardous to descend or ascend. Neither counter-balance, that is the extension from the second floor to the ground, could be lowered without great exertion. After succeeding in lowering the counter-balances they could not be raised. On the Dearborn Street counter-balance the main four-inch channel iron is rusted and broken and the counter-balancing hangs suspended from one tie-rod, and is in danger of falling into the street. These fire escapes stand alone in the entire city, I dare say, for another like them does not exist.

Plenty of Dry Powder Extinguishers.

There is not a single piece of portable fire apparatus in the structure. True it is, there are several dry powder fire extinguishers in an atrociously kept janitors' supply room on the seventh floor. These dry powder extinguishers ceased to be recognized by persons versed in fire extinguishment about twenty-five or thirty years ago.

The inside standpipe equipment is a sham and a tragic joke. Here is a building more than 100 feet in height with a supposed standpipe and fire hose system. The valves controlling the water are located eight or nine feet off the floor and could not be reached without a step ladder. The east standpipe is dry; not a drop of water in it.

Imagine a fire. A person pulls off the fire hose and after stretching it finds no water. Valuable time is lost. Bear in mind, fire is no respecter of persons and it does not wait.

Two and one-half inch rubber lined hose is attached to both east and west standpipes. Had anyone with even a little knowledge of fire hose been consulted on the type of hose for this standpipe, he surely would have condemned this specimen of waste. True, rubber lined hose is used by the Chicago Fire Department, but all our hose is changed and wet twice a week to prevent dry rot. Here is a rubber lined hose that has been hanging, as nearly as it is possible to determine, for ten or twelve years. Imagine the condition of the rubber lining. Unlined linen hose should always be used on inside standpipe fire lines.

The hose cabinets are not marked and all cabinets are storage places for waste paper, bags of old rags and junk, and a veritable breeding place for mice and vermin.

Water Pressure Won't Take Kinks Out of Hose.

The water supply to these fire lines is two tanks on the roof. The steam pumps in the basement pump to the tanks and then the water flows by gravity to the fire lines. I venture to state that the water pressure on the seventh floor, sixth floor or fifth floor will not take the kinks out of the hose, not to mention giving the sturdy stream required for the fire that is possible on these floors.

The Chicago city ordinance requires, in buildings more than eighty feet in height, a pressure of fifty pounds at the highest hose outlet and a 500-gallon per minute fire pump working automatically from a 1,000-gallon cushion tank. It also requires 1½-inch hose attached to a standpipe, not 2½-inch as at present; 2½-inch hose is approved for experienced firemen only. Citizens taking a 2½-inch hose off the standpipe on the lower floors are liable to be injured or even killed. Sufficient hose to cover the entire floor should be provided. At present the hose on a floor will not reach over 50 feet. The building is 200 feet from east to west. A siamese connection should be provided on the sidewalk to enable the Fire Department to pump water to the standpipe fire line.

The chances for a bad fire and a fast spreading one in the basement are ideal. The basement is filled with wooden cupboards, wooden partitions and much combustible material. A gas meter with lead pipe connec-

tion was observed in the Dearborn Street coal room. Old wash pans, old clothing and old pitchers were on top of this gas meter, supported by lead pipes, and immediately next to and touching the gas meter was a nasty wooden locker filled, I fear, with oily clothes and oily rags. Wooden lockers are a prolific cause of fire.

Imagine a fire melting the lead gas pipe, permitting the basement to fill with gas, the fire spreading up the two open elevator shafts and the two open air shafts; the ammonia system in the basement letting go; the ammonia fumes spreading up stairs, elevators and all airshafts; the hundreds of persons in the building in a panic and not knowing the location of the fire escapes.

Granting that some persons do succeed in reaching the fire escapes, over obstructions such as radiators and the telephone switchboard on the second floor, then, I fear, the fire escape would fall.

There is an open pipe-tunnel running from the Criminal Court Building into the basement of the County Jail and the fire, heat, smoke and gases would, no doubt, enter the jail, as there are no doors on the Criminal Court Building end and I was informed that there are no doors on the Jail end of the tunnel. I was unable to enter the Jail so cannot state definitely the conditions prevailing on the Jail end of the tunnel.

I respectfully submit the following recommendations:

1. Repair or replace *at once* the two fire escapes.
2. Discontinue the use of the ammonia refrigerating system.
3. Equip building with a real inside standpipe system.
4. Enclose both elevators for prisoners and both air shafts with tile walls, iron doors and wired glass windows, at least in basement.
5. Remove the doors on fire hose cabinet rooms.
6. Post standard "Fire Escape" signs on all windows leading to fire escapes, these signs to have letters 12 inches high and one-inch face.
7. Discontinue storing old papers, burlap bags, old lumber and old junk in janitors' supply room on the seventh floor; in the custodian's supply room; in the fire hose cabinets; on top of old vaults in west basement; and in the infamous "catch-all-room."
8. Discontinue the use of wooden lockers throughout the building; provide metal lockers.
9. Clean all rubbish and junk from all pent houses on roof and line these wooden pent house doors with sheet metal.
10. Provide standard double fire doors on all entrances into the County Jail; present wooden doors would permit fire to spread from one building to the other.
11. Discontinue the lead connections on the gas meter.
12. Install gas "Exit" lights on upper floor where sleeping quarters are maintained; all doors on this floor leading to rooms having fire escapes to have full glass panels.
13. Place metal lath and two coats of fire-resisting plaster on the open joist ceiling in basement of west section.
14. Tear out and close up wooden air shaft running up from just over vault in west basement.

A Large Open Sprinkler System.

Protection for The Union Central Life Insurance Company Building at Cincinnati, Ohio.

By Capt. M. W. McIntyre.
(Member N. F. P. A.)

The Union Central Life Insurance Company Building at Cincinnati is the first large modern fire resistive office building to be protected against exposure fires by the installation of an open sprinkler system. The main part of this building is 17 stories in height and there is a tower section running up to 34 stories. It has wired glass windows in metal sash in all exposed locations; a part of the original equipment. It is provided with three 6-in. standpipes well located and maintained and with adequate water supply. There are 92 watchmen's clocks, 49 fire alarm boxes, and over 100 fire extinguishers in the building. The building was considered adequately protected until the Burlington Building fire in Chicago on March 15, 1922, demonstrated the tremendous damage which might be sustained by a large fire-resistive office building in a severe exposure fire.*

In view of this experience the owners of the Union Central Life Building were anxious to improve on the existing fire protection provided for the building and for the Company's records. Accordingly the writer, who is manager of the building, was asked to make an investigation and secure all the data possible for this purpose.

After a study of various forms of fire protection the conclusion was reached that wired glass and an open sprinkler system afforded greater efficiency than any other available protection. It was found that wired glass would withstand a temperature of from 1500 to 1700 deg. F. before the glass would melt in the window frames. At high temperatures, however, a sufficient amount of heat might be radiated through wired glass to ignite inflammable material on the inside.

Wired glass windows being already in place, it was decided to place window sprinklers from the seventeenth floor to the ninth floor on the west side of the building, which was down to the roof of the adjoining building on the west. There was a court on this side and the system was

* For a complete report of the Burlington Building fire see QUARTERLY Vol. 16, No. 1, p. 19. See *Proceedings* Vol. 26, p. 252, for a report of the same fire and a round table discussion of methods for protection against exposure fires.

Southwestern view of the Union Central Life Building showing the open sprinkler system in action. The photograph has been retouched to bring out more clearly the pipes of the system and the water flowing from the heads.

extended down into this to the bottom. It was also decided to cover two rows of windows on the north side of the building so that fire coming from the west side could not curl around and come into the building. The south side of the building was provided with open sprinklers from the seventeenth to the third floor, the system lapping two rows of windows on the east side so that if fire came from the south, the eastern exposure of the corner of the building would be protected.

It was realized that this open sprinkler system would be of no value unless there was plenty of water. Investigation was made, before the contract was given for the placing of the sprinklers, to determine the amount of water that would be afforded for the building, while making allowance for sufficient water to fight a severe fire in adjoining properties. It was found that the available water mains included separate 8-in., 10-in., and 20-in. service mains, 10- and 20-in. cross connected service mains, and a 16-in. high pressure service main with water at 180 pounds pressure. Local water works and fire department officials assured the Company that this would afford sufficient water for the purpose of protecting the Union Central Life Building and surrounding territory against any fire that would probably take place within that zone. Six-inch connections to the open sprinkler system were made from mains on the north, east and south of the building. Three 6-in. lines were run into the engine room, attached to a header and cross connected to the 750 gal. per min. steam fire pump. A new electric pump with capacity of 1800 gal. per min. under a pressure of 150 pounds was provided. The electric pump is located 12 feet higher than the boiler room in the engine room and could be used and kept in action at all times should the boiler room be flooded. This pump is provided with a special suction connection so as to pump any surplus water from the boiler room. The two pumps when in operation will furnish 2550 gallons of water per minute. There are two 6-in. fire department connections on the east coming into the system so that the fire department can connect thereon eight 2½-in. hose lines and pump direct into the sprinkler system, if necessary. From the discharge of the two pumps or street connections for the fire department an 8-in. riser pipe was run to the pipe gallery, midway between the sixteenth and seventeenth floors, and then into a header, which is arranged so as to make a distribution for the six discharge pipes through the outside wall to the six 4-in. riser or feed pipes for the sprinkler system. All are controlled by valves in the pipe gallery so that only those feed pipes necessary need be put in service to protect either the west or south sides or any part of the building desired.

There are 291 sprinkler openings on the outside of the building. The installation is not the largest in the number of sprinkler openings that has

Three pumpers taking suction from two high pressure connections and supplying the open sprinkler system through eight lines of hose.

been installed in the United States, but it is the highest above the street level. The sprinkler openings are all turned down toward the windows, which permits the pipes to drain. The branch pipes from the feeder are 1¼-in., 1-in., and ¾-in. All sprinkler openings are fed from ¾-in. or larger pipe. The sprinkler openings at the top of the building are ⅜-in., at the middle they are 5/16-in., and near the bottom, ¼-in. The system was designed to give a pressure of 50 pounds at each one of the openings. This system differs from the usual open sprinkler system in that the water is all pumped to the header in the pipe gallery just below the seventeenth floor and then flows to the outside at the seventeenth floor level and down from the pipe gallery to the lowest sprinkler.

All of the pipes used are extra heavy galvanized wrought iron. All fittings and hangers are of extra heavy galvanized iron. To secure the pipe on the outside of the building, it was necessary to drill through the terra cotta into the brick so as to be able to securely fasten the feeders and branch pipes. There are approximately 5,000 feet of pipe on the outside of the building, its weight being approximately 14,000 pounds.

This installation has been watched with a great deal of interest by many office building managers here and in other cities. A test was made under the supervision of the Ohio Inspection Bureau and the Central

Actuarial Bureau and was carried out to their satisfaction. Data on the water pressures developed in the test may be of interest.

Test Data.

The city water pressure in the engine room of the building was slightly over 50 pounds.

The electric pump brought the pressure up to from 145 to 155 pounds. This afforded water up to the seventeenth floor sprinklers but not with sufficient pressure for effective service. The steam pump was then put into service with the electric pump and a pressure of 172 pounds was maintained. At this pressure water reached all the sprinklers but the pressure at the top row of sprinklers was not very great. It was estimated that 2,400 to 2,500 gallons of water per minute was being used. The inside pumping system was, of course, not intended to furnish complete service as it is not expected that the entire system will have to operate at any one time.

Further tests were conducted with the high pressure mains. Six lines were run into the system at first and the pressure in the engine room was 152 pounds. This test brought water up to the sixteenth floor sprinklers but did not maintain a 10 pound pressure on the heads.

Three pumpers with a combined capacity of 3,500 gallons per minute connected to six openings from the high pressure system and six lines into the sprinkler system. This did not give a sufficient supply of water and extra suction lines and extra service lines from two of the high pressure openings were laid. A pressure of 187 pounds was maintained in the engine room. This afforded sufficient pressure at all the sprinklers on the system.

An Industrial Fire Department Competition.

By George H. Greenfield.
(Member N. F. P. A.)

Competitions between private fire brigades of large industries in the vicinity of Montreal have proved to be very successful in stimulating the interest of the various brigades in their work and in interesting the officials and employees of the participating companies in fire protection. Four years ago the Canadian Car and Foundry Company (Member N. F. P. A.) inaugurated a series of competitive manœuvres for the fire brigades of their various works. The plan was favorably received at the start and has developed so that the annual competition is now planned for as a regular feature by the several brigades.

As far as is known this competition is the only one of its kind conducted in Canada, but the plan could doubtless be advantageously adopted for other localities. The 1923 competition, held on October 6, may be taken as typical of the general methods followed. The following description refers primarily to the 1923 contest:

Two series of competitions are held, one for the four plants around Montreal and one for the four out-of-town plants. A silver cup is donated by the company for the team making the best showing in each group and cash prizes are given to the chief, captain, and men of the winning teams. The cup becomes the permanent property of the works winning it for two successive years. In the four years of competition so far no team has obtained possession of the cup.

Each works sends one team of seven men and a captain, the team being selected by the works' chief.

The 1923 competition was held on neutral ground, the premises of the Dominion Bridge Company, Lachine, P. Q. Representatives of the Canadian Fire Underwriters Association and the Dominion Bridge Company acted as judges and timekeepers.

In the competition the teams were required to wear full equipment consisting of rubber coats, rubber boots, helmets and belts, and spanners. Each team used its own hose truck fully equipped and with not less than 300 feet of 2½-in. cotton rubber lined hose, coupled.

The events were carried out as follows:

1. Hose reel or truck was located 100 yards from the hydrant with caps on butts. A target 30 inches in diameter with a 12-in. revolving disc in the center was located 200 feet beyond the hydrant. The team had to attach the cut-out valve, stretch 150 feet of hose, disconnect it from the truck, attach the nozzle, turn on the water, and hit the target so that the disc would revolve.

2. With the above layout of hose on the ground, the next evolution was to pick up the hose, turn on the water and hit the target, then assume the middle length of hose burst, replace by a spare length taken from the truck, turn on the water, and again hit the target.

3. With the above layout of hose on the ground, the next evolution was to pick up the hose, turn on the water, and hit the target, then shut off, uncouple, take forward first length of hose and add 100 feet of hose, couple up, turn on the water, and hit the target. In this evolution the target was placed 300 feet from the hydrant.

The fastest time turned in on these three events was 39 2/5 seconds for the first, 27 1/5 seconds for the second, and 33 seconds for the third, making a total of 1 minute 39 3/5 seconds for the complete evolution.

Another interesting contest was staged as follows:

A team going into action.

The fire extinguishing contest.

Four fires were built of excelsior, approximately 3 ft. by 3 ft. by 9 in. thick. Each team entered one fireman and the men were lined up ten yards away from the fires, each with a 2½ gallon soda-acid extinguisher. The fires were lighted simultaneously and at a given signal the competitors ran to their fires and extinguished them. This contest provided considerable excitement and amusement. The man who put his fire out first, went over and assisted one of his competitors with the balance of the liquid in his extinguisher.

Aside from the competitions the various teams gave special demonstrations and exhibitions. One team demonstrated the use of 2-in. deluge streams. Another gave a first aid demonstration. Another team showed the use of foam extinguishers on oil fires.

The last event was staged as a surprise by the Dominion Bridge Company, who had an old shed available in a corner of the yard. This shed was well filled with combustible material and saturated with fuel oil. The shed was fired and the fire whistle blown. The Longue Pointe team of the Canadian Car & Foundry Company responded with their 40 gallon chemical engine, while the other works teams, owing to the distance from the nearest hydrant, laid two lines of hose siamesed and backed up the chemical company, putting the finishing touches on the fire.

There were a large number of spectators, including prominent officials of the companies. The competition will continue to be an annual event and is considered to be of real value in promoting the fire protection efficiency of the various works brigades.

Protection for a Modern Office Building.

Safeguarding the Metropolitan Life Insurance Company's New Annex Building, New York City.

By John H. Derby.
(Member N. F. P. A.)

Modern tendencies in fire protection engineering require a close study of the individual property with a view to providing such protective devices as are necessary for the prevention of or protection against fire. The experienced fire protection engineer visualizes the fire which may occur and applies such remedies as will safeguard the property at the lowest cost. Each property is protected on its merits, and automatic sprinklers, automatic fire alarm systems, standpipe and hose, chemical extinguishers, fire brigades, fire doors and other specially designed devices, the tools of the fire protection engineer, each having its special uses, are so prescribed as to promise 100 per cent results. A suitable adaptation of these instruments of fire prevention and protection, for the preservation of life and property from destruction by fire, is what is sought and this is the true art of the fire protection engineer.

Carefully planned fire protective treatment which aims to exactly fit the situation has been adopted in the Metropolitan Life Insurance Company's new annex, a sixteen-story building on the northeast corner of Madison Avenue and 24th Street, New York City.

The building is of superior fire-resistive construction, concrete protected steel frame, with concrete slab floors and roof, and suspended cement plastered ceilings. Elevators, stairways and fire exits are in fire-resistive towers. Horizontal floor exits into the adjoining old annex building, owned and occupied by the Metropolitan Company, are provided. The building contains only a moderate amount of well distributed combustible material, no serious hazards, and is occupied for offices and assembly hall.

The building is equipped with a closed circuit automatic fire alarm system, automatic fire doors and standpipe system. Brief descriptions of these installations follow:

Automatic Fire Alarm System.

Electrical energy for the automatic fire alarm system is supplied by duplicate sets of 60 volt storage batteries, set on glass sand trays, filled

with white sand, supported by a well constructed battery rack. Good ventilation is provided for the storage battery room by two copper louvers, 12 in. x 36 in., near the floor and ceiling. The charging current of 115 volts D. C. is obtained from the Edison public service or the private plant. The charging board and control panels for the fire alarm system are located in the main switchboard room adjoining the storage battery room. Control panels have trouble relays, one for each floor circuit, a master relay, used to transmit coded signals, and supervising relays for the transmitter and gong circuits. Each floor circuit consists of a pair of approved No. 16 rubber-covered wires, in ½-in. standard metal conduit, run in the concealed space between the suspended ceiling and the floor slab, with standard outlet boxes placed fifteen feet on centers. Thermostats, flush with the ceiling, are attached to the outlet boxes. Thermostats are connected in multiple, each circuit being an independent unit, obtaining its current from a common pair of feeders tapped into a terminal block. Between the connecting block and the first thermostat on each circuit, connection is made to an automatic and manual transmitter. Transmitters are connected in turn to a master relay, which sends coded signals throughout the building and also to the basements of the home office building, across the street, occupied as headquarters for the various mechanical trades employed for building maintenance.

Automatic Fire Doors.

Another feature of the building is the arrangement of fire doors between it and the old annex building. The operation of a thermostat or the pulling of a manual box closes the sliding fire doors between the buildings. This is accomplished through means of an electric release which normally holds the door open, but permits it to be shut by hand if necessary. The counterweight is so arranged that during the first eighteen inches of movement there is no retardation. After reaching this point, the counterweight prevents the door from slamming, so that any one in the doorway at the time the fire doors are released would not be injured. Prompt closing of the fire doors shuts off the horizontal draft and prevents the spread of smoke from one building to the other.

Standpipe System.

The standpipe system consists of two 6-inch risers, placed in fire-resistive towers at each end of the building. On each floor there are provided 2½-in. approved angle hose valves, capped, for use of the public fire department, and for the occupants of the building, 1½-in. approved angle hose valves, to each of which is attached one hundred feet of 1½-in. labeled linen hose, provided with galvanized iron smooth bore nozzles, ¾-in. tip, fifteen inches long.

The primary supply to this standpipe system is derived from gravity tanks having a total capacity of nine thousand gallons, located in penthouses on the roof, elevated twenty feet above the highest outlet. The secondary supply is from a 750 gallon Underwriters' steam pump, maintained by an automatic governor at 120 pounds pressure.

The system is capable of withstanding a working pressure of three hundred pounds, if it is desired by the fire department to fight fires across the street, which would require streams of heavy calibre under high pressure.

Chemical Extinguishers.

Two and one-half gallon chemical extinguishers are placed near the exits, which are provided with the regulation exit signs and red lights.

Auditorium.

Another interesting feature of the building is an auditorium having a seating capacity of twelve hundred, which occupies the entire first floor. Ample exits from this auditorium are provided at each end of the room. The auditorium is used for the assembly of company employees and is sometimes rented to organizations for private theatricals, lectures, etc.

Private Fire Brigade.

Employees in the maintenance departments are organized into fire brigades of three watches, so that men are always on duty to receive and respond to signals. They are also trained to use the chemical extinguishers and standpipes installed in the building. Each brigade member with a clear record receives a bonus of $25 a year. Failure to observe the regulations causes a $5 fine for each offense. Five demerits in one year automatically removes the member from the brigade.

The private fire brigade is highly trained and has been so effective that all the fires occurring in the last ten years, thirty-nine in number, have been extinguished without causing undue excitement among the building tenants and with but a nominal property loss.

Fire Tests of Brick Walls.

By S. H. Ingberg.
(Member N. F. P. A.)

Brick walls have been generally recognized as effective in preventing spread of fire, but building codes differ greatly in requirements relating to thickness of walls, owing in large part to lack of definite knowledge regarding their heat insulating properties and stability under fire conditions. Series of fire tests and fire-and-water tests are being conducted at the Bureau of Standards, U. S. Department of Commerce, on walls of representative clay, sand-lime, and Portland cement-sand brick to develop the information necessary for safe and economical construction. The test walls, 11 feet high and 16 feet wide, are built under conditions intended to secure the quality of masonry obtainable in building construction, and in the fire tests are exposed to a controlled test fire on one side for periods up to six hours, which is deemed to cover the range of exposures incident to fires in buildings.

In the fire-and-water tests a hose stream from a 1⅛ in. nozzle under 50 lbs. water pressure is applied over the hot side, following a one-hour fire exposure.

The walls so far tested have either been restrained by being built into rigid containing frames or have been unrestrained with full opportunity for expansion at sides and top. The greater number of walls were laid with brick flat in common or American bond with one header course per five stretcher courses. Some test walls were built hollow with brick on edge, headers and stretchers alternating, of the type known as the all-rowlock Ideal wall construction. The thicknesses were generally 8 and 12 or 13 in., although with clay brick a few tests of 4-in. walls were made. Most of the walls were laid in Portland cement-lime mortar of the proportions 1 :1¼ :6, the batch measure being one bag cement, one bag hydrated lime weighing 50 lbs., and six cubic feet of screened damp sand, the average dry content of which weighed 78 lbs. per cubic foot. Two walls were laid in a 1 :3 Portland cement and sand mortar, and two in a 1¼ :3 hydrated lime and sand mortar.

Test Effects and Results.

On application of heat the greater expansion of the wall materials on the exposed side caused deflection of the central portion of the wall

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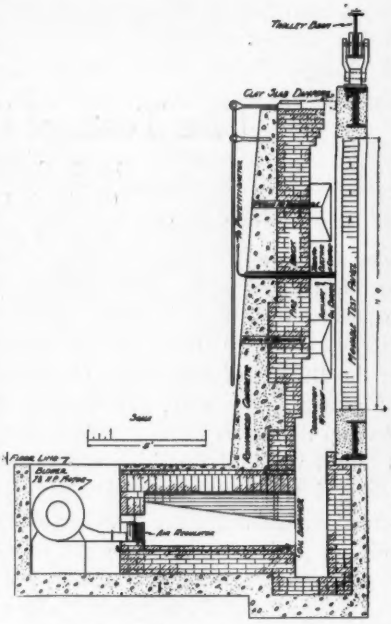
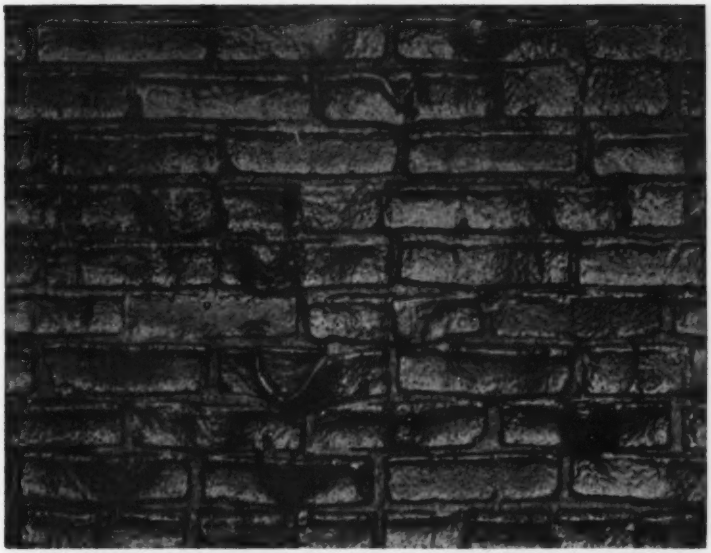
toward the fire and the top of the unrestrained walls away from the fire. No walls eight inches or more in thickness collapsed from deflection. Four-inch walls developed failure or excessive deflection after from three to six hours fire exposure. The cracks formed in the restrained walls were seldom over 1/16 in. wide, except at the borders at the panel frame where larger openings were formed on the unexposed side by the tilting of brick by deflection of the wall. In the unrestrained walls cracks up to ⅜ in. wide were formed on the unexposed side. These generally became smaller toward the exposed side. Little spalling of the brick units in the fire tests occurred although there were frequent longitudinal cracks parallel with the face of the wall ½ to ¾ in. back of the exposed face. Fusion and fluxing up to about ½ in. of brick thickness on the exposed side occurred with one kind of surface clay brick and to a less extent with cement-sand brick. There was also some incipient fusion on the exposed side of the hard sand-lime and the shale bricks, the fusion effects being all confined to the last hour of the test. Only the exposed brick lost strength appreciably from the fire exposure. In respect to freedom from cracking, fusion effects, and loss in strength, the brick may be placed in the following approximate order: Red burning, high fusing surface clay brick; light burning low fusing surface clay brick; Portland cement and high silica sand brick; soft sand-lime brick; hard sand-lime brick; and shale brick. No general separations of exposed and unexposed layers of brick occurred, the one header course per five stretcher courses in the solid walls, and headers alternating with stretchers for the hollow wall, being a sufficient tie against the stresses induced by fire exposure.



Section through test furnace.

Temperatures were measured in the furnace, at representative points within the wall, and on the unexposed surface. Open or imperfect joints in the brick-work were revealed by early steaming on the unexposed side. Temperature changes higher by from 10 to 100 per cent than at the



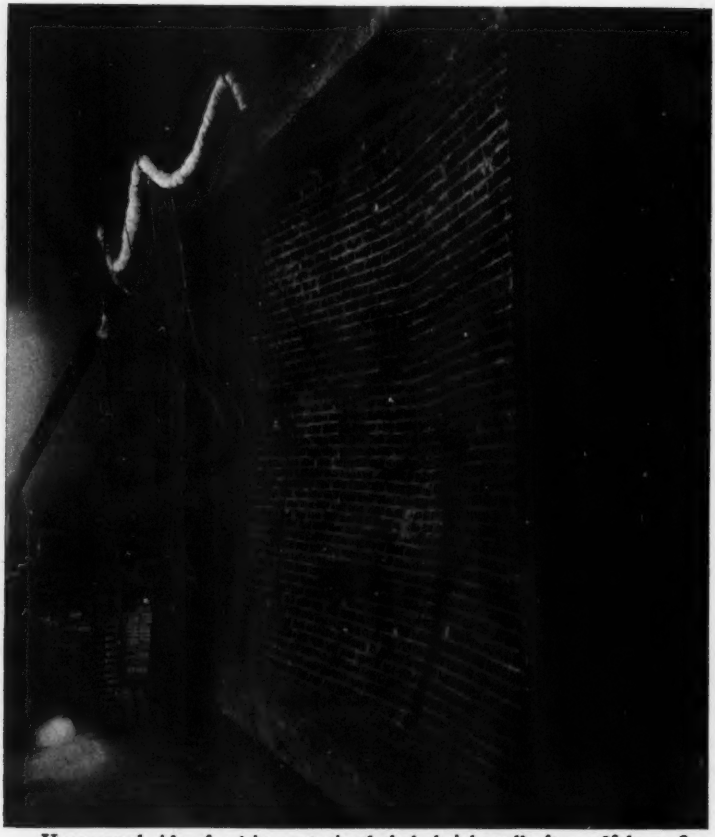
Condition of brick on portion of exposed side of an 8-in. solid unrestrained shale brick wall after a 6-hour fire test. Test. No. 15.

regular outside wall locations occurred at cracks and open joints near the end of the fire tests with 8-in. walls. Under cotton and excelsior pads placed against the outside surface, these temperature increases ranged from five to 60 per cent above those at points freely exposed to the air. The range of maximum temperatures obtaining on the unexposed surface at points exposed to the air and not directly on cracks or imperfect joints, is given in Table 1, the temperatures being in all cases the highest at one of five or more locations at the end of the 6-hour fire test.

Table 1—Maximum Temperatures on the Unexposed Side of Brick Walls at the End of the 6-Hour Fire Test.

Nominal thickness and type	Maximums at regular locations, Degrees Fahrenheit		
	High	Low	Average
8-in. solid	367	192	259
8-in. hollow	522	453	486
12- to 13-in. solid	190	172	179
13-in. hollow	(at 5 hours)		172

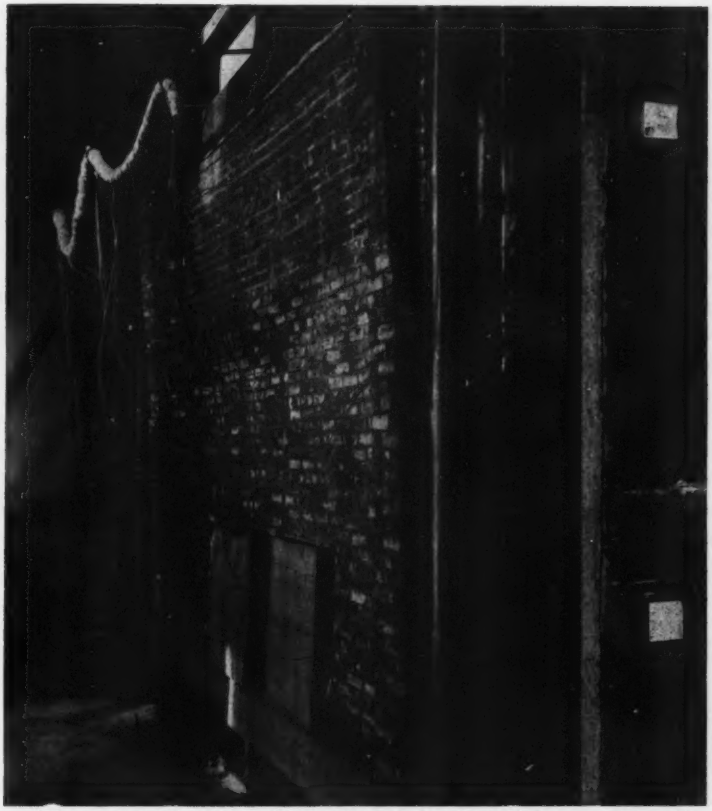
Temperatures were also measured within the walls, the critical point being four inches from the unexposed face which is generally the greatest depth to which combustible floor and partition members are entered. Taking 250° C. (482° F.) as the temperature that may cause ignition of such members, this limit was reached in 8-in. solid walls in 1¾ to 4 hours, in 8-in. hollow walls from 1 hr. 8 min. to 1 hr. 26 min., and in a 13-in.



Unexposed side of a 4-in. restrained shale brick wall after a 2¾-hour fire test. Test No. 13.

hollow wall at 3 hr. 36 min. This temperature was not attained in the 12- and 13-in solid walls, the temperature four inches from the unexposed face being within a few degrees of 222° F. at 6 hours.

The maximum center deflections of the 8-in. restrained walls varied from 1 in. to 5 in., the average for solid walls being 2.64 in. and for the hollow walls 2.24 in. The outward deflection at the top of unrestrained walls ranged from 4.7 to 9.7 in. with average of 7.63 and 6.20 in. for the solid and the hollow type, respectively. For 12- and 13-in. restrained walls the maximum center deflection varied from 1.10 to 2.05 in. and the outward top deflection of unrestrained walls from 6.2 to 9.7 in. Pilasters were built into the 8-in. unrestrained walls to avoid a too extreme condi-



Unexposed side of an 8-in. solid unrestrained Eastern surface clay brick wall after a 6-hour fire test. Test No. 17.

tion, since some support is generally given by cross walls, pilasters and similar details in buildings.

In the fire-and-water tests no general collapse occurred although partial local failure developed at the borders of unrestrained 8-in. walls, caused by the washing out of mortar where the adherence to the brick was weak. The water dislodged portions of the brick cracked in the preceding fire exposure and further loss of material was caused by the sudden cooling and erosion, the damage to the brick being about the same as in the 6-hour fire test.

Conclusions.

The results of the tests are summarized in Table 2 as fire-resistance periods, these being safe units that can be directly applied to building exposures. They are based on the temperatures developed in the tests, with

necessary margins allowed for possible higher temperatures at cracks and imperfect joints and under combustible materials stored against the wall, as well as the possibility of material and workmanship being inferior to that used for the test walls, although considerable care was taken to insure construction representative of actual practice. Materials are considered hazardous that will ignite at temperatures as low as 150° C. (approx. 300° F.), among which can be named nitro-cellulose products (celluloid, etc.), matches, and a considerable number of chemical preparations. Two hundred and fifty degrees C. (482° F.) is taken as the approximate minimum ignition point for ordinary combustible materials of vegetable or animal fibers after the comparatively short exposure incident to building fires. Two hundred and fifty degrees C. (482° F.) is also taken as the temperature at which combustible floor or partition members framed into the wall from the unexposed side may ignite.

Referring to Table 2, the 4-in. wall is given no classification as a load-bearing member because of the high deflections developed. The 8-in. solid wall is given a 4-hour classification for protecting non-hazardous materials as based on temperatures developed on the unexposed side, but the load bearing properties were not sufficiently determined in the tests so far completed to warrant load bearing classification for this period. For the other uses of 8-in. walls where the resistance period is limited by temperatures within the wall or on the unexposed surface to values of 2½ hours or less, it appears safe to give load bearing classification for 8-in. hollow and solid walls, as well as for all uses of 12- and 13-in. walls, as judged by the deflections during test and strength of brick and masonry before and after fire tests. A further series of fire tests of brick walls under load will soon be undertaken that is intended to determine more definitely the strength of 4-in. and 8-in. walls under fire conditions. At the conclusion of this series a report will be issued by the Bureau of Standards on the whole investigation. It is seen from Table 2 that the framing of combustible members into 8-in. walls considerably decreases their fire resistance. The resistance of hollow walls thus used can be increased by filling solidly above, below, and between such floor members, with incombustible material. The 12- and 13-in. solid walls were proven adequate for the full 4-hour period under all conditions.

As an aid in applying the resistance periods given in Table 2 to fire conditions in buildings, it can be tentatively stated that fire experience and some experimental investigations on the intensity and duration of fires, indicate that fires in residence and office occupancies do not generally exceed in severity the first hour of the exposure in the tests, and very exceptional fires, if any at all, will exceed the first 1½ hours exposure. The materials housed can generally be taken as non-hazardous. Fires in buildings used

for merchandising, manufacturing, and storage are known to be of greater severity, possibly in some cases equivalent to the 4-hour exposure, depending on the amount and character of combustible materials present. The above considerations apply to interior exposures. The fire effects on neighboring detached buildings from the burning of an adjacent building can generally be taken as less severe, due to the shielding effects of the walls of the burning building, particularly where of fire-resistive construction, and less opportunity for high temperatures to build up in the open space between them.

Table 2—Fire-Resistance Periods of Brick Walls.

Thickness and Type	Interior structural members framing into wall	Materials protected	Load on wall	Fire-resistance period
4-in., solid	incombustible and fire resistive	non hazardous	non bearing	1 hour
8-in., solid	incombustible	non hazardous	non bearing	4 hours
8-in., solid	incombustible	hazardous	bearing or non bearing	2½ hours
8-in., solid	combustible	hazardous or non hazardous	bearing or non bearing	1½ hours
8-in., hollow	incombustible and fire resistive	non hazardous	bearing or non bearing	2½ hours
8-in., hollow	incombustible and fire resistive	hazardous	bearing or non bearing	1½ hours
8-in., hollow	combustible, on one side only	hazardous or non hazardous	bearing or non bearing	¾ hour
8-in., hollow, filled solid at floor lines	combustible or incombustible	hazardous or non hazardous	bearing or non bearing	1½ hours
12 or 13-in., solid	combustible or incombustible	hazardous or non hazardous	bearing or non bearing	4 hours
12 or 13-in., hollow	incombustible	hazardous or non hazardous	bearing or non bearing	4 hours
12 or 13-in., hollow	combustible	hazardous or non hazardous	bearing or non bearing	2 hours
12 or 13-in., hollow, filled solid at floor lines	combustible or incombustible	hazardous or non hazardous	bearing or non bearing	4 hours

NOTE: When combustible or non-fire-resistive floor members frame into 8-in. walls from both sides, to develop the periods above indicated, they must be so placed and protected as to have not less than 4 in. of solid material between them, and between their ends and the opposite wall surface. The filling at floor lines of hollow walls must be 4 in. or more in thickness above, below, and between the floor members. In the case of 12- and 13-in. walls they must not project more than 4 in. into the wall.

The floor members must be framed to release readily from the wall in case of collapse of floor construction in fires.

For the given resistance periods, load-bearing walls must be laid in cement or lime-cement mortar not leaner than used in the test walls.

The Life of an Automatic Sprinkler.

Canadian Fire Underwriters' Association.

(Member N. F. P. A.)

The life of an automatic sprinkler is not indefinite under any conditions, and under certain conditions it may be comparatively short . . . the life depends on the excellence of its design and construction as well as upon the influence of certain conditions.—*"The Life of an Automatic Sprinkler," by C. R. Alling,* QUARTERLY, *Vol. 4, No. 2, p. 170.*

The practice of inspection departments over many years has been to submit to the Underwriters' Laboratories, or other agency having a testing oven, sprinkler heads from the field, the reliability of which was questioned because of corrosion or other deterioration; but it was not until 1912 that the Fire Underwriters' Uniformity Association undertook to arrange for a uniform method of test and tabulation of results in order to secure data for ready reference in showing the actual condition of sprinklers in the field. In co-operation with the Underwriters' Laboratories and after a preliminary report in 1914, a very complete manual for the uniform conduct of tests and tabulation of results was adopted in 1915, with a decision later not to include in the record test data prior to 1916. The sprinkler industry coöperated in order to relieve the burden of cost to the other interests involved, and annually the Uniformity Association lists the results on clean sprinklers from the field, classified in detail by the various makes and issues. Only clean heads are included as the sole purpose is to determine the deterioration from age in service.

While in the Canadian field the very great majority of the equipments are new since 1903, taken as a whole, the Canadian equipments probably average with those of a like period of service in the United States. Following the recommendation, made by the Fire Underwriters' Uniformity Association in 1918, for a closer study of the heads with a long period of service, tests have been made on a number of equipments that have since come within the fifteen-year period of service. A detailed record has also been kept on the results of the tests, nearly all of which

NOTE:—Mr. Gorham Dana in "Automatic Sprinkler Protection," first published in 1914, under a sub-heading of "Failures from Age," notes that the "limit of life is something generally overlooked and it is quite commonly assumed that so long as no fire occurs, sprinklers have no work to do and should last indefinitely, but that they are working all of the time in holding back the pressure in the pipes, and like any other machine have a limited life." Mr. Dana further estimates sprinkler heads made from 1889 to 1894 and installed in clean, dry locations not subject to corrosive influence, as mostly in good condition for twenty years, with a much longer life for modern approved sprinklers.

have been conducted by the Underwriters' Laboratories. This record is radically different from that of the Uniformity Association in that it includes all heads tested irrespective of their condition or the reason for submission, and not solely clean sprinklers. The very great percentage of the heads, however, have been those in service fifteen years and those secured for renewal tests at the request of the Underwriters' Laboratories under their follow-up system, and not by reason of appearance. The record has been summarized from May, 1918, to October, 1923, or a little over five years.

The uniform test report of the Underwriters' Laboratories includes a description of the condition of the heads about to be tested and an opinion of their reliability. The test on each head is given in detail and the result listed as satisfactory, slow, doubtful or inoperative. Condition is classified as clean, dusty, dirty, painted, calcimined, loaded, corroded, damaged, etc., with subdivisions of slightly, moderately or severely under the loaded and corroded conditions; or a combination of deteriorating influence from "dusty" on. A recommendation is made for action to be taken on the equipment as a result of the test of the sample heads.

TABLE I.

Summary of Field Tests of Automatic Sprinklers by Underwriters' Laboratories.

(May 1918—October 1923)

No. of Properties		369	Opinion Before Test—	
Years of Service	Longest	31	Reliable	5163
	Shortest	¼	Not Reliable	101
No. of Heads Tested		5420	None Given [1]	156

Condition of Heads and Results of Tests.

	Clean	Dusty	Dirty	Calcimined or Painted	Loaded (All Degrees)	Corroded (All Degrees)	Misc.[2]
Satisfactory	159	645	1007	306	204	317	34
Slow	82	341	656	279	238	493	105
Doubtful	2	22	57	36	27	125	4
Inoperative	10	29	63	13	31	125	10
Totals	253	1037	1783	634	500	1060	153
Per cent doubtful or inoperative	4.7	4.9	6.7	7.7	11.6	23.6	7.8

Total doubtful or inoperative 549; percentage of number tested 10%.

Action Taken	Total No. Sprinklers Replaced	31,256
	Cases Whole Equipment Replaced [3]	19
	Cases Partial Equipment Replaced [3]	76

[1] Eighty-six heads tested by the Factory Mutual Laboratories.
[2] Includes a few wax-coated, cleaned, and damaged.
[3] Practically one equipment in four replaced, from a few heads to entire system.

TABLE II

Condition of Heads and Results of Tests
Canadian Fire Underwriters Association

CLASS OF OCCUPANCY			Pulp Mills[1]	Paper Mills	Packing Houses[2]	Tanneries[3]	Flour Mills[4]	Oil Cloth Works	Starch Works[5]	Paint and Varnish	Sugar Refining[6]	Soap Works	Mercantile and Light Manufacturing 20 Years and Over[7]	Miscellaneous 25 Years and Over[8]
No. of Properties			12	4	6	5	5	1	2	6	2	3	13	22
YEARS OF SERVICE		Longest	25	18	26	22	17	28	21	27	18	21	27	31
		Shortest	1	½	1	3	2	7	4	5	7	4	20	25
		Average	11	10	15	14	12	18	13	19	15	12	21	27
No. Heads Tested			304	53	131	111	74	103	103	114	103	34	126	313
CONDITION OF HEADS	Clean	Satisfactory	20			2	4		8		1		1	
		Slow	33	3	11				5				2	
		Doubtful						1						
		Inoperative							3					
	Dusty	Satisfactory	14	3		3	22	19	7	20			12	25
		Slow	10				4	4	2	1			7	8
		Doubtful					2	1					1	2
		Inoperative					1		6	1				
	Dirty	Satisfactory	8	2	3	19	2	25	6	29	19	2	23	68
		Slow	35		7	7	13	12	1	15	19	2	17	39
		Doubtful						2			1		6	7
		Inoperative				3		2	3		3		2	7
	Calcimin'd or Painted	Satisfactory	2		1			1	1	6	3		15	8
		Slow	12		5		2	1		3	7		15	22
		Doubtful	2					1		2				3
		Inoperative								1	1			2
	Loaded all degrees	Satisfactory	8	2	2	7	9	17	11	10	4	6	3	34
		Slow	32	4	19	8	10	2	16	9	13	1	1	22
		Doubtful	3	3	1	1		2	1			1		4
		Inoperative	4	4						1	7		2	1
	Corroded all degrees	Satisfactory	20	18	8	14	2	1	10	5	8	16	4	17
		Slow	52	7	28	32	2	11	14	9	10	5	1	29
		Doubtful	30	2	3	13	1	1	2	1			2	8
		Inoperative	19	5	17	2			7	1	7	1		3
	Miscellaneous	Satisfactory			7								4	
		Slow			14								8	
		Doubtful			1									1
		Inoperative			4									3
Summary Total Doubtful or Inoperative		Total No.	58	14	26	19	4	10	22	7	19	2	13	41
		Per Cent	19	26.4	19.8	17.1	5.4	9.7	21.4	6.1	18.4	5.9	10.3	13.1
		Min. Service. Years	2	6	8	12	12	16	6	14	9	10		
		No. in Class with Hds. Db. or In.	10	3	6	4	1	1	2	4	1	1	7	14
		Per Cent in Class with Heads Db. or In.	83	75	100	80	20	100	100	67	50	33	54	64

[1] Clean heads include a number of wax coated in good condition.

[2] Practically all sprinklers wax coated on installation.

In Table I, on page 251, it may be noted that while only 101 sprinklers, or practically 2%, were thought before testing to be unreliable, 549, or 10%, were found on test in a doubtful or inoperative condition. No criticism of the opinion expressed is intended, but simply to emphasize the fact that visual examination from the floor level of sprinklers in an equipment is not a safe method to determine their reliability. Of course there are times when appearance is sufficient evidence of the need for replacement without a test; but in the average situation it is much better to ascertain by means of tests whether sprinklers are reliable or not.

Of the 5420 sprinklers tested, only 253 were classed as clean, or under 5%. As previously stated, while the record includes heads submitted for whatever reason, the very great percentage were under the fifteen-year minimum service period and were taken as they came without reference to appearance. It is estimated by the Underwriters' Laboratories that 3% would be a fair average for clean sprinklers from the field generally, out of the total tested by them.

It would appear, then, that even in situations where the least deterioration of the sprinkler heads may be expected, the percentage that can be classed as clean after a considerable period of service is very small. What is really wanted is a knowledge of the reliability of the equipments as they stand in the field after years of service. Therefore, to classify only clean sprinklers may lead to a false security, for before such heads indicate the need for replacement, the very great percentage of the equipment will likely have reached the unreliable stage, even if the dusty sprinklers be classified with the absolutely clean ones. The argument against a general classification is that the results on clean sprinklers will determine whether any particular type is becoming generally defective from age in service, and confusion may result from inclusion in the records of heads deteriorated because of local conditions, and action on such is a matter of the individual equipment.

Sprinkler Life Expectancy by Occupancies.

One opinion is that the solution of the difficulty is in a classification of the life expectancy of sprinkler heads by occupancies, or, more accurately, by processes or occupancy of room. A shorter life would naturally be found where the processes cause severe corrosion or loading. A

[3] All upper leather tanneries.

[4] Tests mainly due to heat fumigation.

[5] Defective high degree heads in dry kiln give high percentage of failure.

[6] Heads from one refinery, from warehouses only, heads in refinery proper condemned before start of these tests subsequently replaced.

[7] 2 department stores, 2 retail stores, 2 wholesale dry goods; 2 clothing factories; 2 offices and light manufacturing, formerly department stores; 1 office building, formerly wholesale dry goods; 1 wholesale dry goods light manufacturing; 1 retail store and fur factory.

[8] 3 wire and screw works; 2 shoe factories; 2 drug manufacturing; nail works; saw mill; omnibus, formerly paint factory; omnibus, formerly telephone manufacturing; drug manufacturing, formerly shirt factory; clothing factory; school; woolen mill; general storage, formerly electrical apparatus manufacturing; oil cloth works; printer; varnish works; theatre; cotton mill; packing house.

minimum of two and a maximum of twenty years are estimated as the two extremes, with cement works and fertilizer factories as examples of the short life expectancy, and department stores, office buildings and similar occupancies of the longer. There is a further argument that such life tables would do away with continuous testing, would determine the amount annually chargeable to depreciation of sprinkler equipments, and would result in systematically removing the older heads from the field.

Through the courtesy of the Grinnell Company, who recently inquired of a number of the inspection departments for the classes of hazard causing sprinkler deterioration, arranged in the order of their severity, there is given a tabulation of the replies, listed in such order, as follows:—

> Tanneries, bleach and dye works, chemical and acid plants, pickling, plating and galvanizing rooms, paper mills, pulp mills, fertilizer and rendering works, packing plants, stables, storage of green hides, soap and glycerine factories, sugar refineries, cold storage, open areas (including driveways, platforms, etc.), grain elevators, storage battery rooms, saw and planing mills near salt water, salt works and salt storage, ammonia, linseed oil factories, lard oil refineries, garbage reduction plants, starch and glucose factories, match factories, wool carbonizing, wet portions of hat factories, vinegar works, foundries, glue works, woodworkers, lime storage, wet basements, oilcloth works, rubber reclaiming works, acid storage, rag picking and cleaning, hair felt factories, steam rooms and laundries, locomotive sheds, flour mills, paint factories.

This list is not considered final either in arrangement or number, for it omits, for instance, reference to dust hazards such as cement and plaster works and carborundum factories, where the sprinkler protection is likely to be seriously impaired through the caking of non-inflammable dust. It, however, is a good starting point for further study.

In Table II, the classification by occupancies does not include a sufficient number of properties in each class or of heads tested to permit the drawing of conclusions. With such a small number, one generally defective equipment will have an undue effect on the results for its class. Another reason for possible inaccuracy is that heads might have been found defective earlier if tested sooner. This record shows, however,

NOTE:—In both the 1916 and 1917 meetings of the Uniformity Association, there was reference by the representative of the Underwriters' Laboratories to the hope that some day they would be able to classify sprinkler heads by occupancies; but recent correspondence with the Underwriters' Laboratories indicates they do not yet feel in a position to offer any reliable data for the guidance of the inspection departments, pointing out the difficulty that comes from the large number of classes of occupancies and the widely varying conditions in any given class of hazard. Practically the same argument has been advanced by several others whose opinion has been sought, that is, the arrangement of the hazard causing the deterioration to the other rooms or buildings of a property, and that the height and ventilation of these portions themselves will have a material influence on a sprinkler equipment. The majority opinion, however, of the few who have been consulted, is favorably disposed to the idea of life expectancy by occupancies.

the value of classifying by processes, for it will be seen that with certain of the hazards, impaired sprinklers have been found in practically every plant. It would be necessary to combine the experience of the various inspection departments over a considerable time, to arrive at an average period in service in the various classes where impaired protection may be expected. Unusually favorable or unfavorable conditions, which may lengthen or shorten the average life for the process, it is believed, will largely take care of themselves. No table of averages can be completely accurate, for there will always be exceptions to the general rule, as with mortality tables in life insurance; but the law of average there has been a safe guide and should apply similarly with tables of life expectancy of sprinklers by processes.

The tables of general classification and for mercantile and light manufacturing occupancies, with equipments 20 years and over, and for the miscellaneous classes with equipments 25 years and over, are added to indicate the general experience with equipments that have been in service for a considerable period.

It is realized that such a general classification is of no value for specific application in another field; but combined with the experience of others, it may serve as a general guide, and may at least be advanced to support the arguments in this article.

Follow-up Service in Tests.

The follow-up service adopted by the Underwriters' Laboratories in these tests has proven its worth. The tests of six or eight sample heads from even a small equipment does not necessarily show the general condition of the heads in the system. In several cases it has happened that the first test has been favorable, but has been reversed by the second several years later. However, the tests of small lots of sample heads of the same makes and issues from a number of properties indicate their general reliability, and a few equipments have been replaced because of a high average percentage of failure even where the showing of the heads from the individual system has been more favorable.

The general practice with the Canadian Fire Underwriters' Association is to send one copy of the report of the Underwriters' Laboratories to the property owner, even when the result of the test is satisfactory. The majority of reports naturally are favorable, and in transmission to the property owner there is a statement that additional samples will be requested in several years. The property owner is pleased to receive the favorable report, learns to appreciate the value of the test service, recognizes the fact that heads may suffer from service conditions, and is being prepared for the eventual recommendation to replace the heads.

Fire Experience.

There is nothing in the fire record of the N. F. P. A. to show that deterioration of sprinkler heads has resulted in unsatisfactory sprinkler performance, except that there is a rather high percentage of unsatisfactory fires[1] in some classes with a high percentage of doubtful or inoperative sprinklers. Even where sprinklers control a fire, they may have been slow in operation because of deterioration and the loss may be consequently greater even though the fire is not classed as a sprinkler failure.[2]

Conclusions.

It is felt that the results justify the field tests of sprinkler heads as now conducted by the Underwriters' Laboratories, and within reasonable limits, or at least until there are reliable tables on the life expectancy of sprinklers by processes, it is believed that securing sample sprinkler heads for test from equipments with a considerable period of service, even when appearance does not indicate any deterioration, should be made a part of the regular inspection work. Notwithstanding all of the safeguards placed around shop practice, so long as the human element enters, as it must, into the manufacture, it is quite possible that there will be an occasional head, or small lots of heads, inferior to the average. Only in this way can a few failures of standard heads be accounted for. This does not lessen the value of the protection as a whole, but the aim should be to discover any serious defect that may exist in an equipment before the fire.

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[1] See Table 8, p. 407, April, 1923, QUARTERLY.

[2] NOTE:—Three illustrations since this record was started can be given: one a fire in a woodworker opening ten heads, in service nineteen years. One head exposed to fire failed to open. The second was in a wood room of a sulphite pulp mill. Heads had been in service sixteen years but apparently in good condition; twenty-two opened. The charred appearance of the ceiling indicated slow operation. The third was in a mercantile building opening six heads where the major portion of equipment had been in service eighteen years. The inspector believed that if the three heads nearest the fire had opened promptly, the other three, of a later and better issue, would not have fused.

In each case, tests of sample heads by the Underwriters' Laboratories resulted in the equipment being replaced, yet none of the three fires could be classed as a sprinkler failure.

There have been eight other fires where it was thought sprinkler heads should have operated but did not; but in only one case did subsequent test by the Underwriters' Laboratories prove that the sprinkler head was at fault. Draft conditions or insufficient heat probably accounted for the failure of the balance to fuse. In two cases the head was within 15 inches of a burning electric motor—probably much smoke and little heat.

NOTE:—The author makes acknowledgment particularly to Mr. R. W. Hendricks of the Underwriters' Laboratories for much information and assistance out of the regular routine, and to Mr. G. P. Deering of the Factory Mutual Laboratories, Messrs. Alfred G. Fritzsche and Henry A. Fiske of the Grinnell Company, Mr. J. R. Hamilton of the Automatic Sprinkler Company, and Mr. Frederick C. Moore of the Hartford Fire Insurance Company.

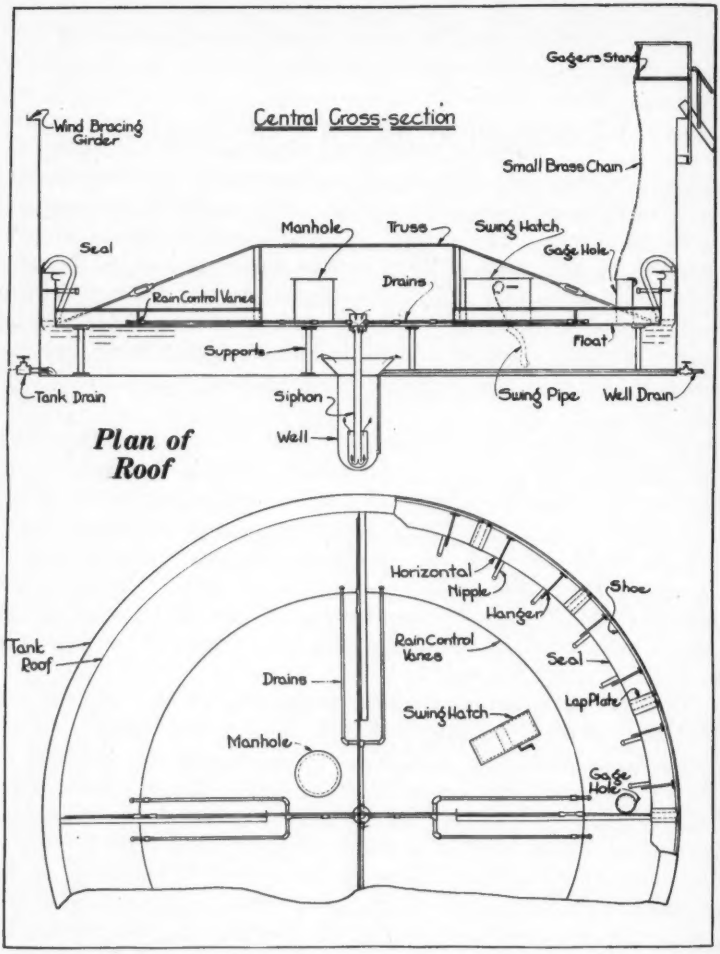
Floating Roofs for Oil Tanks.

The petroleum industry is devoting a continually increasing amount of attention to the prevention of losses due to the evaporation of petroleum products in storage. New devices are being developed almost daily to reduce such losses. Some of these, such as those which retain the more volatile constituents of the oil by means of pressure, may add materially to the fire hazard involved in petroleum storage; others, while designed primarily to reduce evaporation losses, incidentally operate to decrease the fire hazard. (E.g. see article on Sealite, QUARTERLY, V. 16, No. 3, page 250.)

Among the more recent developments in the prevention of evaporation losses with attendant reduction in fire hazard, which is always more pronounced where conditions are such that vapors are freely given off by the oil, is a new type of roof for oil tanks known as the "floating roof," which practically eliminates the vapor space from the surface of the oil, thus removing one of the chief causes of evaporation, incidentally eliminating the possibility of explosive mixtures of gas and air from the surface of the oil in the tank, and reducing the fire hazard materially according to the results of recent fire tests.

There are at present two types of floating roofs, which, while similar in fundamental principle, differ mainly in the method of making contact with the inside shell of the tank. One type of floating roof is known as a floating tank deck, and has on its circumference flexible metal baskets containing gravel that rest against the inside shell of the tank. In the other type of floating roof, contact with the tank shell is made by the use of movable buffers or shoes. These are attached to the outer ring of the roof and are pressed against the tank shell by means of springs. The details of the arrangement of this roof are shown by the plans reproduced on pages 258 and 259. The arrangements provided to drain the water from the roof shown in the drawing on page 258 introduce some mechanical complications, but from the viewpoint of fire protection are not important. The following description by the manufacturer will serve to explain the mechanical details.

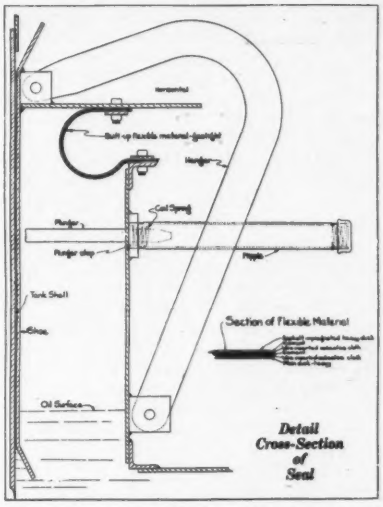
Float.—The float is the main body of the roof and consists of a blanket of steel $\frac{1}{8}$ inches thick and one foot less in diameter than the tank. The vertical rim of shell is about 17 inches high, also of $\frac{1}{8}$-inch plate. The entire float is preferably electric welded. There is sufficient trussing to maintain the cross-section of the roof in a substantially level straight line.



Plan and Central Cross Section of the Floating Roof. For detail of the seal see diagram on page 259.

Seal.—The seal is the means of joining the roof to the shell of the tank in sliding contact. It consists of a shoe, a horizontal, a flexible gas-tight fire-resistive material, a spring pressed plunger, and curved hangers. The seal is made in sections, flexibly joined to the top of the rim of the roof and to each other. The shoe having the same curvature as the tank, and beveled to ride over plates and rivets affords close contact with the shell of the tank for a vertical distance of about 24 inches. The horizontal shelf piece is welded to the shoe and the whole is supported by practically frictionless hangers which are so disposed as to cause the weight of the seal to throw itself positively against the tank. As the shoe comes closer to the roof

than its normal distance, it engages a spring-pressed plunger carried by a horizontal nipple. This plunger aids gravity in pushing the seal against the shell of the tank. The flexible material between the seal and the rim of the float is built-up of two layers of wire inserted asbestos cloth cemented together and two layers of heavy canvas, one layer on either side of the asbestos. The canvas which is on the weather side is treated with hot asphalt before application. This construction corresponds substantially to the best type of built-up roofings. It should last at least five years and is easily replaced at small cost. Though this connecting material must be flexible while applying it, yet, once in place its movement is very slight during emptying and filling of the tank. Therefore there is not sufficient movement to wear it out or break it down. It is really gas-tight and fire safe. It is bolted to the seal and the roof and held in place by bars. This construction practically gives the roof the effect of a flexible steel shell which is at all times kept in close contact with the shell of the tank and follows any irregularities. Several self-closing openings are placed in the rim of the roof which vent the very small gas-tight space between the shoe and the rim.



Detail of seal, showing shoe in contact with inside of tank shell at left. (See also plan, page 258.)

Rain Control System.—In designing for the worst conditions of rainfall it is necessary to assume a cloud-burst. In such a case several inches of water may have to be carried on the roof for a period of time before it can all be drained off. A design to carry six inches will cover most cases. In the Gulf Coast region it will probably be necessary to design for a greater possible depth of water on the roof and a more rapid rate of drainage. At any rate, to carry any such amount of water, it is necessary to have some control system for preventing all the water that falls from collecting on one side. Such a control system is obtained by dividing the upper surface of the roof into a number of pockets eight to 10 inches high and of balanced area. This is accomplished by welding or riveting vertical vanes to the roofing.

Rain Drainage System.—There are two general classifications of tanks as to duty. Some tanks are filled and emptied practically all the time, while others which are used for storage purposes are filled only occasionally. The rain drainage system for this roof consists of: (1) One of several practicable methods of draining the water from each pocket of the rain control system to a central drain; (2) either a siphon and well or a pantographic arrangement of pipes. The former conducts the water into the bottom of the tank. The latter leads the water to the outside of the tank. The siphon has two main advantages over the pantograph, namely, it has no moving parts to get leaky and it can be removed and repaired. In the case of the siphon, the rain water is drained from the bottom of the tank periodically through the regular water draw-off valve. The pantograph has the advantage for storage that stands for long periods, that the rain is conducted outside the tank. Working tanks, however, such as at refineries or on pipe lines, have daily and sometimes hourly gages. It is very little trouble in most cases, then, to drain the water

from the bottom of the tank after each rain. Either system, the siphon or pantograph, can be installed, but owing to the great advantages presented by the siphon for working tanks, this latter is recommended. The only function of the well in the center of the bottom of the tank is to receive the siphon, which is about ten feet long. There is a drain attached to a point near the bottom of the well for drawing the water off the roof when the tank is nearly empty.

Wind Bracing.—The tank with a floating roof must have some kind of wind bracing since the canopy type roof which performed this function is now removed. To carry the wind load, a girder or stiffening angle is placed at the top of the tank. This girder also keeps the tank in round at all times.

Minor Features.—A small railed platform is placed at the top of the stairway. This platform projects slightly toward the center of the tank. The gage hole—8 inches in diameter by 18 inches high—is placed beneath the platform so that the gager can drop his thief through the hole while standing at the top of the tank. A small brass chain extends from the thief hole cover to the stand. A pull on the chain opens the cover. Releasing the chain shuts the cover. Since there is no reason to go into the tank when empty other than for repairs or cleaning out, no ladder is provided in standard equipment. A manhole 20 inches in diameter and 20 inches high is located near the center. Its cover is bolted on and is gasketed.

The shoe, connected to the roof proper by a flexible gas-tight and fire-resistant fabric, is pressed against the inside of the tank shell by means of springs so that it is separated from the shell only by the thickness of the rivet heads or plate laps. The free oil surface thus exposed is calculated to be on the average ¼ inch wide. With a standard 55,000 barrel tank the area of the exposed oil surface is 15 square feet as compared with an exposure of approximately 10,000 square feet with the ordinary canopy roof tank of the same size. The evaporation from this narrow gasoline surface is even smaller than the relative area would indicate, for the shoe projects upward a considerable distance above the oil level, thus forming a narrow slot through which air circulation is slow and consequently evaporation from the bottom of the slot is retarded. According to claims made for this roof with the 55,000 barrel tank the annual evaporation losses will be from 100 to 300 gallons of gasoline according to the grade of oil stored and the use of the tank, as compared with from 750 to 6,500 or more gallons evaporation loss from the usual type of gas-tight tank, such as is specified by the N. F. P. A. Regulations. The saving is even greater when compared with the wooden roofed tank. These savings amount to from $400 to $26,000 a year with a 55,000 barrel tank according to the kind of oil, rate of pumping, etc.

A series of fire tests was made to determine the value of this floating roof from a fire protection viewpoint. The following description of some of these tests is quoted from a report by Mr. Ludwig Schmidt of the U. S. Bureau of Mines.

The fire tests were divided into several parts in order to determine the effect of fire at different points on the roof. The tests were made on the

Courtesy Chicago Bridge and Iron Works.

One of the fire tests of the floating roof oil tank. Gasoline fire on the roof.

afternoon of September 25, 1923. The average atmospheric temperature was 75° F. with moderate to fresh southerly winds.

Test No. 1 was made to determine the effect of a flame brought into contact with the vapors in the opening between the shoe and the tank shell. Also attempts were made to ignite the exposed portion of the gasoline by dropping a lighted taper into this space. In each instance there was a flash around the circumference of the tank, which consumed the gasoline vapor and air mixture already in this opening. There was no evidence of fire after the first flash. It is interesting to note that when the flame was lowered into the slot between the shoe and the tank, the flash occurred when the flame was about half way between the surface of the gasoline and the mouth of the slot.

Test No. 2 was made to determine the effect of a small fire on the roof of the tank near the center.

Several quarts of gasoline were poured on the roof near the center and ignited. The fire burned for a little over six minutes. At times the flames were about six feet high. This gasoline burned without igniting the exposed gasoline in the slot around the shell. However, this was a comparatively small fire and the flames did not reach the shell of the tank.

Test No. 3 was made to determine the effect of a steady fire on a shoe of the roof.

About two quarts of gasoline were poured on the shoe of the tank and ignited. This burned for about two minutes. There was only one flash around the circumference of the tank, as occurred in Test No. 1. The exposed gasoline in the slot between the shoe and the tank shell did not ignite.

Test No. 4 was made to determine the fire hazard when the roof was covered with inflammable material and was the severest test of all. About five gallons of gasoline were poured on the roof and ignited. The fire burned for a little over fifteen minutes. The flames constantly licked over the side of the tank and in the center they were about eight feet high. In several places around the shoe the exposed gasoline caught fire and burned for about five minutes after the gasoline on the roof was consumed. The fire around the shoe was extinguished by cooling the hot shell of the tank, shoe and tub of

the roof. One man accomplished this by using four 2½ gallon fire extinguishers. Part of the contents of the last extinguisher was played directly on the flames.

These tests show that it is practically impossible for gasoline to burn continuously in a tank properly equipped with a floating roof as described, even though the vapors between the shoe and the tank shell are ignited by means of sparks or fires. However, if there is any inflammable material on the roof and it is ignited, it will heat the gasoline immediately under the roof so that it will vaporize. The vapor escaping around the shell will then become ignited and burn until the inflammable material on top of the roof is consumed. In Test No. 4 in order to extinguish the fire, the roof around the shell was first cooled, thus preventing the rapid formation of additional vapors. The ease with which the fire was extinguished indicates that the fire would probably have snuffed itself out if the seal had been vapor tight. As a matter of fact in a later test made on this roof after the seal was made gas tight, it was reported that the fire snuffed itself out after the inflammable material on the roof had been consumed.

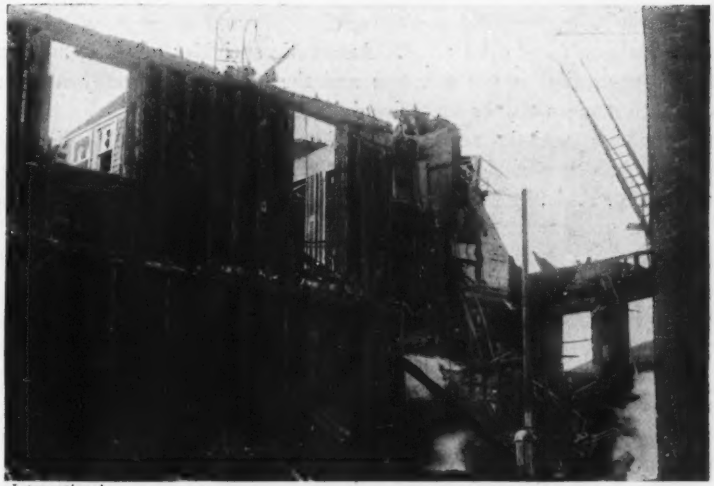
Conclusions.

The floating roof promises to be of material value in reducing the hazard of ignition of individual tanks as shown by the foregoing test data. It is questionable, however, whether this type of roof would be of value in protecting against severe exposure fires.

The Rosemary Hall Fire.

The main building of Rosemary Hall, a girls' boarding school in Greenwich, Conn., was destroyed by a fire which occurred at 3:45 A. M. on Sunday, November 11, 1923. Although fifty-five people were in the building at the time of the fire, every one escaped safely due to the excellence of the fire drill. The building was a large frame structure. The fire started in the basement, either in the kitchen or boiler room, from unknown cause. Forty-seven girls were asleep on the second and third floors. One girl smelled smoke and awoke the student fire captain who immediately rang the alarm bell. Every girl carried out the fire drill requirements and in three minutes after the bell had sounded, all of the students were assembled in formation on the terrace outside and the roll was called. The fire drill rules are very strict. Before "taps" each fire lieutenant checks up on the girls in her squad, making sure that each one is present or accounted for. Each girl, before she goes to sleep, leaves at the foot of her bed a polo coat, goloshes, a wrapper and slippers. At the alarm she dons these, turns on the lights, shuts the door and windows in her room and descends the stairs.

Girls with special assignments carried these out with dispatch. One girl aroused three servants on the third floor. Another girl telephoned for the fire department. Another saw that the hose and fire extinguishers were in place. Another notified the nurse in the infirmary of the fire.



International.

Ruins of the main building of Rosemary Hall, Greenwich, Conn., after fire of November 11, 1923.

The volunteer fire department responded promptly and might have controlled the fire but for the absence of adequate hydrants and the low water pressure. Other buildings of the school were not close enough to be in danger.

The striking feature of this fire was the value of a well planned fire drill. Had there been confusion and hesitation it is probable that loss of life would have resulted.

The Resort Hotel.

The veritable epidemic of resort hotel fires experienced during the past vacation season again calls attention to the prevalent lack of fire protection which has always existed in this class of buildings. According to the fire records of the *New York Journal of Commerce,* during the months of June to September inclusive, twenty resort hotels were burned with a total loss of $3,310,000. The figures indicate the very high values involved in these fires and the usual total destruction of the property.

Unfortunately the resort hotel has apparently not kept pace with other types of buildings in improved construction and fire protection. Many of these buildings are of light frame construction with wooden

shingle roofs, unprotected stairways, elevators and other floor openings, and containing large open areas. Automatic sprinkler or other adequate interior protection is not common and the location is usually not convenient to modern city or town fire departments.

The characteristics and hazards of resort hotels were ably discussed in a paper on Season Hotels delivered before the eleventh annual meeting of the N. F. P. A., by Mr. H. L. Hiscock, and in a report on Hazards and Protection of Summer Hotels, by Mr. Gorham Dana, in the October, 1909, QUARTERLY. The facts set forth therein apply equally well today. Mr. Dana says in his report, "it would seem that the time was about ripe for decided improvements in the construction and protection of this class of property." It is now fourteen years later and the same remark holds true. To be sure, when one of these hotels burns to the ground it is usually rebuilt with at least some precautions against fire, but in few cases is any attempt made to improve the fire safety of the frame hotel already standing.

The reasons for this apparent indifference to proper fire protection may be largely due to the nature of the business. The popularity of a resort hotel is subject to fluctuations not under the control of the proprietor. Certain localities may be fashionable one year and unpopular the next. The large city hotels are sure of a permanent patronage provided their service is up to the standard and the owners can afford to build permanent fire resistive structures. The resort hotel is open for less than half of the year as a rule and its success is more or less dependent on the whims of the public. This basic condition of the business may serve as an excuse for not building expensive structures but it is not an excuse for permitting hazardous conditions to exist or for neglecting proper fire protection measures. The proprietor of the resort hotel should realize the responsibility that he is under for the safety of his guests. The large frame unprotected resort hotel is a potential death trap and should be recognized as such.

Another possible reason for the common lack of fire protection in the resort hotel may be the lack of supervision and inspection. The city hotel is erected in compliance with a building ordinance and is subject to frequent inspection by city and insurance inspectors. The resort hotel is often erected without being subject to any building requirements and may be infrequently visited by insurance inspectors if insured or otherwise not inspected at all.

The fire record files of the N. F. P. A. include 79 fires in resort hotels during the past fifteen years. While this number of fires is probably only a fraction of the resort hotel fires during this period the fires included in the record are typical and a study of them is of interest.

Resort Hotels—Fire Record.

(1908-1923)

Causes of Fire

	No. of Fires	Per Cent
Matches—Smoking	15	25.0
Sparks on Roof	14	23.4
Heating	11	18.3
Defective Electric Wiring	7	11.7
Defective Chimneys	5	8.3
Electric Pressing Iron	2	3.3
Lightning	3	5.0
Miscellaneous	3	5.0
Total Known Causes	60	100.0
Unknown Cause	19	
Total	79	

Analysis of Loss.

	No. of Fires	Per Cent
Loss less than $5,000	27	34.2
Loss more than $5,000	52	65.8

Time of Day.

	No. of Fires	Per Cent
6 A. M. to 6 P. M.	38	48.1
6 P. M. to 6 A. M.	32	40.5
No Data	9	11.4

Of the 51 fires where the place of origin of the fire was given, only ten started in guest rooms. A number started on the roof and most of the others in the basement where the heating plant, kitchen, and laundry is usually located.

It is safe to say that no other classification of occupancy in the N. F. P. A. fire record files has such a high ratio of large loss fires as 65.8 per cent. Of the 79 fires, 37 resulted in the total destruction of the hotel. In 28 fires the property loss was over $25,000.

Again quoting from Mr. Dana's report, "The ideal summer hotel from the point of view of safety, is one built entirely of fire-resisting construction, with all floor openings shut off; with power plant, kitchen, laundry, and all other hazardous portions located in detached or cut-off sections; and with adequate inside fire protection. Such a hotel would be expensive, especially in localities remote from cheap transportation facilities, but in most cases it would be ultimately economical.

"In a hotel of frame construction, however, it is possible to make improvements that will render it comparatively safe at a cost that is not prohibitive, . . ."

Anyone familiar with the ordinary precautions against fire could sug-

Courtesy of Fire and Water Engineering

The Profile House fire, August 2, 1923.

gest to the proprietor of a frame hotel ways and means by which he could greatly increase the safety of his property. Perhaps the most obvious necessary precautions are the proper protection of vertical openings, fire stopping of walls, floors, and partitions, and the replacement of shingle roofs with fire resistive roof coverings.

One most necessary feature is the provision of adequate exit facilities. Every occupant of the hotel should be able to reach the ground safely by at least two routes. Directions for quick escape should be posted in each room. Exits should at all times be kept clear and should be made obvious by signs and lights. A night fire in a hotel full of sleeping people too often takes a heavy toll of life. The Wawa Hotel fire, described later in this article, is the most recent example of this nature.

The condition of the chimney and the kitchen ranges and flues is very often bad from the fire hazard standpoint and is a hazard that can usually be readily eliminated.

There are many kinds of processes involved in the functioning of a large resort hotel. The more hazardous of these, such as the laundry, garage, carpenter shop, etc., should be housed in fire resistive buildings detached from the hotel proper.

The provision of proper fire walls to cut off sections of large frame hotels will very materially reduce the probability of total or heavy property loss as well as loss of life by fire. Such walls should completely cut off one section of the building from another. They are useless unless well built and unless they extend well above the roof and out beyond the sides of

the building. Proper automatic fire doors should of course be provided.

Fire protection devices and facilities should naturally be of the very best in a large flammable structure housing many people. Automatic sprinkler installations, either throughout the building or in the basement and kitchen and other hazardous locations, are the most desirable form of protection. Not one of the seventy-nine hotels included in the fire record above was equipped with a sprinkler system. The splendid record of sprinklers in safeguarding lives and property is the only argument necessary for their use in resort hotels. One large resort hotel in California makes an advertising feature of its automatic sprinkler system.

The provision of adequate hydrant and standpipe systems with ample water supplies is a most important feature. Liberal provision of chemical extinguishers and water pails is always desirable. Approved automatic alarm systems, if properly maintained, will give a quick warning and eliminate the dependence on the human factor which has caused the delays resulting in many resort hotel disasters.

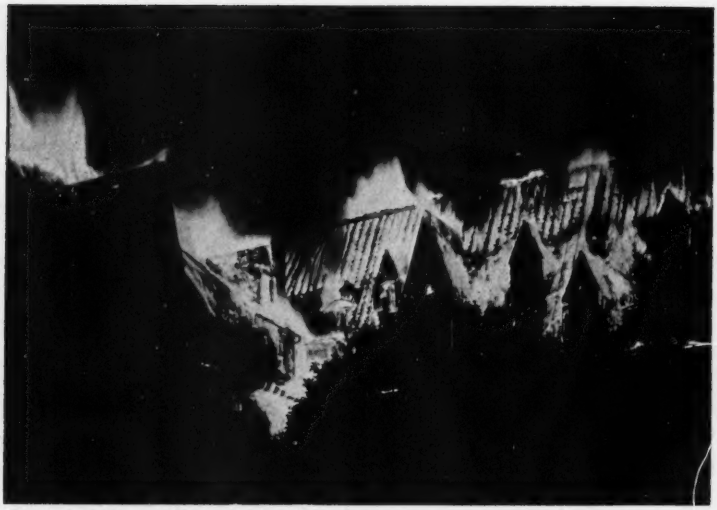
An examination of reports of disastrous hotel fires indicates the importance of having someone responsible for the care and maintenance of fire fighting equipment and the direction of activities in case of fire. Many of these hotels are remote from public fire department protection and the fighting of a fire is up to those on the premises. If nobody knows what to do or where to find needed apparatus the building burns down.

As in every other occupancy care and cleanliness is vitally important. Every employee of a resort hotel should function as a fire warden and correct or report hazardous conditions noted. The presence of careless guests makes this watchfulness doubly imperative.

The obvious hazard of the frame resort hotel and the very poor fire record of this class of property, particularly during the past season, should bring about immediate reform, interest in fire safety replacing, the indifference to fire protection now so common. If only the public that patronizes these hotels would refuse to tolerate unsafe conditions improvements would quickly and certainly follow.

Typical Resort Hotel Fires in 1923.

H-19270. Anniston Inn, Anniston, Ala., January 3. The main building was of part brick and part frame construction four stories in height and of large area. The fire started at 3 A. M. in the attic, presumably from defective electric wiring. It was noticed by an outsider who gave the alarm, but by the time the fire department arrived the fire had gained headway and was beyond control. The building was unsprinklered and the fire was fought entirely by hose connections to public hydrants. The building was destroyed with a loss of $138,000.



Courtesy of Fire and Water Engineering.

The Imperial Hotel fire at Narragansett Pier on September 6, 1923.

H-19455. ARLINGTON HOTEL, HOT SPRINGS, ARK., APRIL 5. This was a very large unsprinklered brick and frame structure covering approximately three-quarters of an acre. The fire started at 2:45 P. M. under the floor of the main hallway, probably from a short-circuited electric wire. An alarm was given and the fire department responded within five minutes. The space under the main floor was not high enough to permit proper access to the fire and the firemen had to cut through the marble and tile floor of the hallway to get at the fire. The flames spread up through the hollow partitions to the roof and this made it impossible for the firemen to control the fire. The hotel was burned to the ground with a loss of $870,000. One fireman was killed by a falling wall.

H-19853. MOUNT TAMALPAIS TAVERN, MILL VALLEY, CALIF., JUNE 30. This building was a frame unsprinklered shingle roof structure not accessible to any public fire department. Sparks from the kitchen flue set fire to the shingle roof and the building was totally destroyed with property loss of $63,000.

H-19812. PROFILE HOUSE, FRANCONIA, N. H., AUGUST 2. This was a large summer hotel of light joist construction consisting of a group of several buildings joined together and several detached buildings. There was a building occupied as servants quarters 110 feet west of the main buildings and a large stable and garage 250 feet beyond. A boiler house and laundry was 200 feet north of the main buildings and there were 20

cottages east of the buildings, many being connected to the hotel by a covered passageway. All the buildings had shingle roofs. The main buildings were four stories and attic in height.

The only fire protection consisted of three standpipes fed by tanks of about 40,000 gallon capacity and a fair supply of chemical extinguishers. The hotel was not readily accessible to public fire departments in nearby villages.

The fire started at 11:45 A. M. in an upstairs room and soon spread to the dry shingle roofs. The draught conditions were favorable to the rapid spread of the fire as the hotel was located in a notch between high mountains. The inadequate fire fighting facilities had no effect on the fire and all the buildings, with the exception of the boiler house and laundry, were burned to the ground. There were 300 guests at the hotel and most of them lost all their belongings. The loss on the buildings was $325,000.

H-19824. WAWA HOTEL, MUSKOKA, ONT., AUGUST 19. This building was a large two-story frame structure with shingle roof. The interior division walls were of half inch Georgia pine covered with burlap. The fire started at 12:25 A. M. in a baggage room and spread with incredible rapidity throughout the building. There were 240 people in the hotel. Nine women lost their lives in the fire, six of whom were employees occupying rooms in a tower not properly equipped with facilities for escape. The entire structure was burned to the ground within 30 minutes after the start of the fire. The property loss was $325,000.

A 4-in. main circled the hotel with four hydrants connected to it. The water supply consisted of an 18,000 gallon tank, supplemented by water from the lake pumped by steam pump. Only one hydrant was used as most of the hose was not accessible at the time of the fire. This hydrant was abandoned on account of the heat shortly after the fire started.

There were 17 inside standpipe connections but this system was practically out of commission during the fire as the water supply was shut off at the main valve in the kitchen. There was no organized fire brigade responsible for the maintenance of the fire equipment or for action in case of fire.

H-20036. IMPERIAL HOTEL, NARRAGANSETT PIER, R. I., SEPTEMBER 6. Fire occurred in this large frame unprotected hotel in the attic at 4:20 A. M. An alarm was immediately given by an outsider and the fire department promptly responded. Aid was called from four neighboring towns. The rapid spread of the fire soon involved the whole structure and the firemen devoted themselves to saving surrounding property which was deluged with sparks and flying brands. The hotel was totally de-

All that was left of the Ottawa Beach Hotel, Ottawa Beach, Michigan, after a fire on November 4, 1923. The loss was $295,000.

stroyed with loss of $400,000. An adjoining frame hotel, the Massasoit, was saved by excellent work of the firemen but was damaged to the extent of $5,000.

H-20031. Asbury Park, N. J., October 6. Fire starting in a frame theatre building quickly spread to a group of large frame unsprinklered hotels and within three-quarters of an hour four of these, the Bristol, Edgemere, Deswick, and Victoria were destroyed. Only by excellent work of the fire department were three others saved. Fortunately all the hotels were closed for the season and no lives were lost. The property damage was $400,000.

H-20133. Ottawa Beach Hotel, Ottawa Beach, Mich., November 4. This hotel was a large frame structure unprotected and with open stairways and large open areas. The hotel had been closed for the season some time before and a tank which supplied the hotel with water had been drained. The buildings were all locked up with no one on the premises. The fire presumably started from defective electric wiring as the current had been turned on the day before the fire to test out the lights for a new dance hall that had just been completed. An employee of the hotel, who was passing by, noticed the fire and telephoned to the nearest fire department nine miles away. The fire spread rapidly and by the time a pumper arrived and could draught from the lake, all that was left for it to do was to save a few small surrounding buildings. The main hotel and annex were completely destroyed.

Domestic Oil Burner Fires.

The hazard of the domestic oil burner has received widespread attention, as is evidenced, for example, by the general interest shown in the article on "Safeguarding Domestic Oil Burners," by Curtis R. Welborn, in the October QUARTERLY. Only a few reports have been received on fires in domestic oil burners during the past few months, but these are of interest in indicating the common causes of oil burner fires.

The following reports on four domestic oil burner fires which have occurred in St. Paul during the past fall are furnished by Mr. John Townsend, Jr. (member N. F. P. A.), Superintendent of the St. Paul Fire Insurance Patrol. None of the burners involved in these fires were approved by the Underwriters' Laboratories.

1. Fire occurred in a domestic gravity feed oil burner while the family was out of the house. The burner was fed by a pipe leading down from the service tank. It was lighted by allowing a small amount of oil to run into the burner and applying a match. The size of the flame could be regulated by a hand valve according to the degree of heat desired. Any oil not consumed runs back through an overflow pipe into a trip pan fastened to a shut-off valve. In event of an overflow of oil into the trip pan the weight of the oil causes the pan to fall, cutting off further flow of oil. The check valve had become so corroded that the weight of the oil was not sufficient to close it and burning oil ran out on the floor. Fortunately the family came home shortly, shut off the oil and extinguished the fire before it had done any damage other than smoking up the house.

2. This fire was due to a poorly constructed domestic oil burner. The oil is fed to the burner by gravity and an electric motor forces air into the burner to aid combustion. A gas pilot light burns continuously in the burner. The valve shutting off the supply of oil from the service tank had been closed but the valve was defective and allowed a small quantity of oil to run into the burner. This oil was ignited by the pilot light. As the motor was not running the burning oil ran back through the overflow pipe into the trip pan, filled that and ran over on the floor. The fire did no damage except to smoke up the house.

3. This burner was similar to the one described in the preceding report. In installing the burner the overflow pipe was set higher than the pan under the burner used to catch surplus oil. The gas pilot light went out. When the temperature of the house dropped below the point

set on the thermostat, the oil flowed into the pan under the burner and from there to the bottom of the furnace. The oil could not run into the trip pan because the overflow pipe was improperly placed.

When the owner came home he found oil all around the outside of the furnace. He shut the valve and telephoned the firm that installed the burner. A man was sent who cleaned up the oil outside but failed to even look inside the furnace where most of the oil had collected. He lit the gas pilot light and the oil in the bottom of the furnace immediately caught fire. The fire department extinguished the blaze with foam. Flames did not get outside the furnace but the house was badly smoked up.

4. This fire was caused by negligence of workmen in installing a burner rather than by any defect in the burner. The burner is of the pressure feed type. Air pressure is pumped up in a storage tank from the the city water supply, a pressure of about 15 pounds being maintained. The shut-off valve is closed by the release of a lead weight by the trip pan rather than by direct operation of the trip pan. It is probable that the men installing the burner neglected to set the trip pan. The flow of oil into the burner was probably too great and the burning oil flowed back into the trip pan and then to the floor where it set fire to the wall. The fire occurred on the day the burner was installed. It was extinguished with small loss.

The Washington Surveying and Rating Bureau (member N. F. P. A.) reports the following oil burner fires that have occurred in Seattle during the fall.

Pump Type Burner.

1. Strainer clogged up with sand. When sand had been removed and oil started to run to burner, the gas from the oil was ignited by heat in the fire box.

2. Leak in feed line near burner permitted oil to run under fire box and ignite.

3. Leak in feed line near burner; oil leaked under fire box and ignited.

4. Leak around burner; oil leaked into ash pit and ignited.

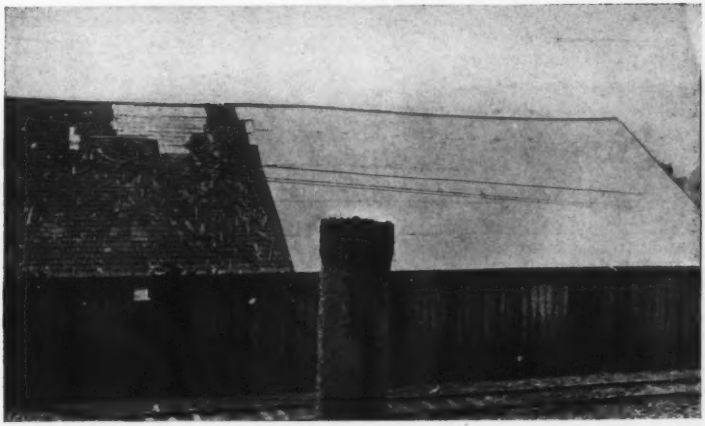
5. Burner clogged and stopped flow of oil. When clogging was removed the oil formed a gas and the heat of the fire box exploded it. The walls of the furnace were blown out.

6. An explosion occurred in the fire box from unknown cause. The walls of the fire box were blown out. One man was injured.

Pressure Type Burner.

1. Leak in feed line allowed oil to get into fire box and ignite.

2. An explosion occurred in the fire box from unknown cause.



Fires from Oil Engine Exhaust Soot.

Two fires quite definitely attributed to hot soot or carbon discharged from the exhaust pipes of internal combustion engines are reported by C. F. Wieland (member N. F. P. A.). Both of these are of special interest because of the fact that the soot or carbon apparently retained, for a long period after leaving the exhaust pipe, sufficient heat to start a fire.

The photograph reproduced above shows in the foreground the exhaust pipe of an internal combustion engine serving a municipal water pumping station. This exhaust pipe is eighty feet away from the frame warehouse shown in the background. The shingle roof of this warehouse was ignited and the building partially destroyed. The light part of the roof indicates where repairs have been made.

In the other fire reported two exhaust pipes were carried through the roof of the building, but evidently did not extend high enough above the roof to prevent hot particles of carbon or soot being carried into the building through a louver opening in a roof ventilator.

In both these fires it is not clear whether the hot carbon was discharged directly from the engine exhaust or whether it was carbon that had accumulated on the surface of the exhaust pipe and was later dislodged. In either case it was due to imperfect combustion in the engine.

NOTE:—It is requested that readers of the QUARTERLY who may know of similar fires send details to the Executive Office. It is hoped that data on a number of such fires will permit generalizations as to the distance that fire may be carried by means of flakes of soot or carbon and the extent to which this material may retain a temperature sufficient to cause ignition.—ED.

Protection Against Exposure Fires.

The problem of providing adequate protection against exposure fires is a difficult one and one that has never been satisfactorily solved. The fire record data on this subject has been found so meagre that it has usually been difficult to reach any satisfactory conclusions. Every exposure fire is different from the next. So many factors are involved that generalizations are next to impossible; one type of window protection will perform splendidly in one fire and utterly fail in another. There may be important differences in both the character of the exposure fire and building protected. In one fire the window protection may be supplemented by excellent fire department or private fire brigade work and in other cases, particularly in conflagrations, the protection may be called upon to withstand an unusually severe fire without outside assistance. Varying wind conditions may also be an important factor.

Interest in this subject has been greatly increased by the Chicago fire of March 15, 1922, in which the fifteen-story fire-resistive Burlington Building was severely damaged from an exposure fire across an 80-foot street, and by the round table discussion on "How Can Buildings Be Protected from Severe Fire Exposure," which took place at the 1922 annual meeting of the N. F. P. A. in Atlantic City. At that meeting and in later discussions it was clearly brought out that there was no one simple solution to the problem and that the greatest need was a careful study of past experience in fires and some sort of a classification of the various types of protection available.

In the hope that some helpful data might be contributed to this problem the Executive Office has made a study of 544 exposure fires recorded in the files of the Department of Fire Record. These fires are subdivided and classified in Table I. In analyzing this and the data following, it should be borne in mind that the record is not complete, including but a small proportion of the total number of exposure fires. Presumably the majority of fires where the protection of the exposed building proved satisfactory are not reported to the Department of Fire Record; no report is made because there is no fire damage. On this account the tables probably indicate for all types of protection an efficiency considerably less than that which would be shown if *all* exposure fires could be included in the record.

Table I.

Protection	Effect of Fire: No or Slight Loss to Building	Partial Loss to Building	Heavy or Total Loss to Building	Total No. of Fires
FRAME BUILDINGS.				
Unprotected	4	24	33	61
Sprinklered	1	35	11	47
Sprinklered+Open Sprinklers	13	18	7	38
Sprinklered+Wired Glass	1	0	0	1
Sprinklered+Tin Clad Shutters	0	1	0	1
Sprinklered+Open Sprinklers+Tin Clad Shutters	0	0	1	1
Sprinklered+Iron Shutters	0	2	0	2
Wired Glass	1	0	0	1
Tin Clad Shutters	0	1	0	1
	20	81	52	153
BRICK OR FIRE-RESISTIVE BUILDINGS.				
Unprotected	8	37	31	76
Sprinklered	35	109	20	164
Sprinklered+ Open Sprinklers	19	15	2	36
Sprinklered+Wired Glass	6	23	2	31
Sprinklered+Tin Clad Shutters	5	25	5	35
Sprinklered+Iron Shutters	0	7	2	9
Sprinklered+Wired Glass+Open Sprinklers	2	4	0	6
Sprinklered+Open Sprinklers+Tin Clad Shutters	2	2	1	5
Sprinklered+Wired Glass+Tin Clad Shutters	1	2	0	3
Open Sprinklers	1	1	0	2
Wired Glass	2	6	3	11
Tin Clad Shutters	1	3	2	6
Iron Shutters	0	1	1	2
Wired Glass+Tin Clad Shutters	1	4	0	5
	83	239	69	391
Grand Total	103	320	121	544

The term "No or Slight Loss to Building" does not necessarily mean that the protection provided was entirely successful as the result may be influenced by other factors such as fire department work and severity of the fire. Under "Partial Loss to Building" may be both fires classed as window protection successes or failures. A fire where the window protection held but fire entered the building through the roof or on an unprotected side would be placed in this class. A fire where the window protection failed but where inside sprinklers prevented heavy loss would also be placed in this class.

It would be difficult to draw any general conclusions from this table both on account of the aforementioned variable factors and because there are not a sufficient number of fires in each classification to demonstrate clearly the value of the protection involved.

In order to get a better comparison of the efficiency of the various types of protection, Table II sums up the data on each type without regard to construction of building or other protection involved.

Table II.

Protection	Effect of Fire: No or Slight Loss	Partial Loss	Heavy Loss	Total No. of Fires
Unprotected	12	61	64	137
Sprinklers Alone	35	143	31	209
Open Sprinklers	37	40	10	87
Wired Glass	14	40	5	59
Tin Clad Shutters	10	38	9	57
Iron Shutters	0	10	3	13
	108	332	122	562

As might naturally be expected, only 12 out of 137 unprotected buildings escaped without loss. The saving of these 12 buildings was due in most cases to the effective work of the fire department or private fire brigade. The showing of automatic sprinklers is interesting. In most cases fire entered the building but was controlled inside by the sprinklers. A serious exposure fire is necessarily a severe tax on a sprinkler system as fire may enter on all floors and open a large number of heads. Ten of the 31 failures were in conflagrations where a large number of heads were opened and where the water supply was in most cases deficient because of heavy draught by the fire department. Sprinklers should not be expected to control exposure fires and the fact that they were more or less successful in 178 out of 209 cases is a tribute to their efficiency.

Table II would indicate that open sprinklers are the most effective window protection, followed respectively by wired glass, tin clad shutters, and iron shutters. A more detailed study of the fires involving these various forms of window protection bears this out.

Table III.

Distance from Exposing Fire	Effect of Fire: No Loss	Partial Loss	Heavy Loss	Total No. of Fires
Adjoining Building	58	143	52	253
1 to 25 ft.	17	85	21	123
26 to 50 ft.	14	28	13	55
51 to 100 ft.	10	36	5	51
Over 100 ft.	0	5	3	8
Conflagrations	0	12	25	37
No Data	3	11	3	17
	102	320	122	544

Within certain limits, the distance of the exposed building from the exposing fire, as shown in Table III, apparently has little effect on the amount of damage. The proportion of no loss fires and heavy loss fires reported remains approximately the same regardless of the distance. It seems reasonable to suppose, however, that many fires when the distance from the exposing fire is great have not been reported in cases where the protection has been successful and there has been no loss. If *all* exposure fires were included in the tabulation the showing of distance as a protection would accordingly be much more favorable.

Comparison of the Several Types of Protection.

In a comparison of open sprinklers, wired glass and shutters, tin clad and iron, it should be noted that every type of protection has some inherent weakness. All of these forms of protection, except shutters and wired glass windows which are kept permanently closed, depend upon the human element which is a very important factor as will be brought out later. In this particular respect wired glass windows show a decided superiority over the other types of protection, for windows in buildings of the average occupancy are normally closed and under ordinary circumstances may be expected to be found closed in time of fire. It is a significant fact that in the several wired glass window failures summarized on a following page, no cases are reported where fire has entered a building through open wired glass windows.

Shutters must be closed and open sprinklers turned on when the fire comes. If shutters are normally closed, except when the building is occupied, at which time there is a reasonable chance that the occupants may be able to close all the shutters promptly, they may be on a par with other types of protection as regards the human element. When the building is not occupied and shutters are left open, it is often practically impossible for the one or two watchmen or others who may be in the building to close all the shutters in time to prevent entrance of fire or before the exposing fire becomes so hot as to prevent access to the shutters.

The open sprinkler system also depends upon the human element. It must be turned on when needed, but it has the advantage that it is usually so arranged that all the sprinklers may be turned on by one man at some point remote from the exposed wall.

Assuming that the several types of protection are properly used, there still remain certain physical deficiencies inherent in each type. The open sprinkler requires large water supplies which are often not available when needed; the wired glass window transmits radiated heat and melts under the influence of unusually high temperatures; the iron shutter prevents the direct transmission of flame and radiated heat, but has itself no insulating value. The wooden tin clad shutter, if properly installed, maintained and closed, has perhaps the least inherent deficiencies of any of the several types mentioned, but is so often not properly used that the records show its performance to be inferior to that of open sprinklers and wired glass windows.

This record unfortunately does not include data on some of the protection arrangements which have recently come into general favor. There are, for example, no fires in the record which throw any light on the efficiency of rolling steel shutters.

It is now generally agreed that for protection against severe exposure a combination of two or more types of protection is necessary. Combinations of open sprinklers and wired glass windows, wired glass windows and shutters, shutters and open sprinklers, are each undoubtedly superior to any single type of protection alone. In the detailed descriptions of fires following will be found a number of instances in which two or more types of protection functioned. There are not enough of such fires, however, to permit including them in general tabulations which would show the efficiency of such combined protection or to draw any general conclusions. In cases where there has been more than one type of protection, the fire has been classified according to the type of protection which seemed to be the predominating factor in the particular fire under consideration. The record does show very conclusively the value of interior automatic sprinklers as a reënforcement for outside sprinklers, wired glass windows or shutters. As will be brought out in the record there are a large number of cases where inside sprinklers prevented the spread of fire which had penetrated the window protection.

In the following discussions of the several types of protection, it will be noticed that the dividing line between success and failure of the window protection is not sharply drawn. This is necessarily a matter of judgment in many cases and the classification of any given fire as a success or failure for the protection involved depends upon a number of factors, such as the severity of the exposure fire. The criterion taken in this classification is whether protection is or is not the deciding factor in preventing an exposure fire from entering the exposed building. For example, if in a conflagration an open sprinkler system results in the saving of an exposed building, this is classed as a success for the open sprinkler system even if one or two of the heads become clogged and it is necessary to back up the open sprinkler system by hose streams at one or two windows. On the other hand, if a building protected by wired glass windows, for example, is exposed and combustible material inside the windows is ignited by radiated heat and the fire is extinguished by an inside sprinkler system, the case may be classified as a failure for the window protection, if it appears from the report that inside sprinklers would have prevented the entrance of fire even if there had been no wired glass and the wired glass was not of material assistance.

Open Sprinklers.

There are 87 fires recorded where the exposed building was equipped with an open sprinkler system. In 48 cases the system functioned satisfactorily; in 15 cases the system failed to protect the building; and in 24 cases the system was not a factor. All things considered this is an ex-

Open sprinklers saved this building. See report S-2715 on page 280.

cellent showing. In most of the cases reported the exposing fire was severe, and as can be seen from the following analysis of the 15 failures, not all of these can be blamed directly on the inadequacy of the open sprinkler system.

Reason for Failure	No of Fires
Inadequate water supply	4
Explosion wrecked system	3
System not turned on	2
Fire penetrated water curtain	2
Conflagration conditions	1
Falling wall wrecked system	1
High wind blew water away from building	1
System not on exposed side	1
	15

If the open sprinkler system is well arranged and maintained, backed up at all times by plenty of water under good pressure, and if someone who knows how to turn it on is at hand, it is of unquestionable value even under the most severe exposure conditions. The record shows that where the open sprinkler system has fulfilled its designed function, that is, where it has continuously *wet* all windows and exposed combustible surfaces, it has been practically universally successful; failures have occurred only where for some reason the open sprinklers have not wet all exposed surfaces. Following are brief summaries of some of the more interesting and typical fires in which open sprinklers were involved.

Open Sprinkler Successes.

(Including some fires in which open sprinklers were only partially successful.)

S-3633. JULY 6, 1903, STONEHAM, MASS. A frame shoe factory was severely exposed by a fire which destroyed a group of frame buildings 25 feet distant. The open sprinkler system along the exposed wall of the factory consisted of forty open sprinklers at the cornice. These operated effectively, the only damage to the factory being the cracking of window glass and the charring of part of the cornice out of reach of the open sprinklers.

S-2715. JAN. 18, 1904, AMESBURY, MASS. Fire started in a five-story unsprinklered frame carriage factory with a four-story wing extending to within about forty feet of the exposed building. The latter was a four-story sprinklered frame building provided with wooden shutters and open sprinklers extending for 80 feet along the wall nearest the exposing building. The shutters and the open sprinklers effectively kept the fire from entering the building. The fire caught on outside the building just beyond the shutters and open sprinklers and came through the windows on each floor. Sprinklers inside operated and prevented the fire from getting a foothold but the side of the building was burned through for a space of 15 or 20 feet on all floors. The accompanying illustration gives an excellent idea of the work done by the open sprinklers. The exposing building was destroyed.

S-7527. APRIL 19, 1904, TORONTO, CANADA. This building, involved in the Toronto conflagration, was of brick, ordinary light construction, and was provided with open sprinklers on the west and south. The course of the fire was from a group of three and five-story buildings on the west, some immediately adjoining and some 20 feet distant. The composition roof was first fired but the fire also gained entrance through an unprotected doorway and through windows on the upper floor where the water pressure was too low to effectively operate the outside sprinklers, and against which a strong wind was blowing. At the south where the building was severely exposed by a furniture warehouse, the open sprinklers were, except on the upper floors, entirely effective. On the upper floors the inside sprinklers opened and made up the deficiency, entirely preventing the fire from gaining entrance on this side. The assistance given by the open and inside sprinkler equipment of this building was the turning point in bringing the conflagration under control, although the building itself was considerably damaged.

H-1451. DECEMBER, 1906, MONTREAL. Fire occurred in a five-story unsprinklered brick building. Across a 15 ft. alley was a five-story brick building with twenty-five good sized windows (of ordinary glass in

wooden frames) with an open sprinkler over each window. When the fire was well under way the watchman in the exposed building turned on the water for the open sprinklers. The water curtain operated for over two hours with the result that no damage was sustained and not a pane of glass broken. The mercury during this time ranged from ten to seventeen degrees below zero. The heads remained clear throughout but as soon as the pressure was shut off the water in the pipes immediately froze. The exposing building was entirely destroyed.

S-7034. MAY 22, 1908, DAYTON, OHIO. Fire occurred in a group of frame buildings, seriously exposing a sprinklered paper box factory located across a 50 ft. street from the burning buildings. Open sprinklers along the front of the building, facing the fire, were put into service promptly and did excellent work in keeping fire out of the building. Two of the open sprinklers were clogged and it was necessary to bring hose streams into play to extinguish flames at these points. The outside sprinklers undoubtedly saved the building and prevented a conflagration of considerable magnitude.

S-8082. Nov. 27, 1908, JAMESTOWN, N. Y. The building, of iron clad frame construction, was severely exposed by a fire in a five-story unsprinklered frame furniture factory 22 feet distant. The open sprinklers were turned on and effectively kept fire out of the building. A frame tank tower on the roof was not protected by the open sprinklers. The fire jumped across to this tower but sprinklers inside operated and prevented spread of the fire. The firemen were able to stand close to the wall of the building and play streams on the fire under the protection of the water curtain. It is doubtful if they would have been able to approach the building on account of the intense heat if the open sprinklers had not furnished protection.

S-10503. Nov. 26, 1910, BROCKTON, MASS. Fire started in a three-story frame unsprinklered stable 8 ft. distant from a four-story frame sprinklered shoe factory. On the exposed side of the shoe factory were two lines of open sprinklers over the windows on the third and fourth floors, the top line protecting the cornice. Heads were about 8 ft. apart with ½ in. orifices. The water supply was from a 10 in. city main at 65 lbs. pressure. The open sprinklers were put in commission as soon as fire was discovered in the exposing building and before flame had burst through the windows. The open sprinklers did excellent work and prevented any damage to the shoe factory.

S-11508. JULY 14, 1911, BROCKTON, MASS. Fire occurred in a three-story frame metal clad building 8 ft. from a four-story frame sprinklered factory. The exposed side of the factory was protected by two lines of

open sprinklers over the third and fourth-story windows. Heads were about 8 ft. apart. The water supply was from a 6 in. connection from a 10 in. main at sixty-five pounds pressure. The open sprinklers did excellent work until steamers reduced the pressure. After this fire was kept out by employees with water pails. Some damage was done to the window sashes but no fire entered the building.

S-11572. JULY 17, 1911, NEW LONDON, CONN. Fire started in a two-story frame building 25 ft. distant from a frame factory building. Open sprinklers on the exposed side of the factory were turned on and effectively prevented the fire from spreading into the factory. The shingle roof of the factory caught in several places but the firemen easily extinguished this fire with hose streams. The exposing building was burned to the ground.

S-14099. JAN. 3, 1913, LONG BRANCH, N. J. Fire occurred in a two-story brick and frame store adjoining a two-story frame department store. When discovered by the department store watchman the fire was well under way and a small hole had already burned through the frame wall. The open sprinkler system on this side (25 heads) was immediately turned on, forming a water curtain which effectively extinguished the burning clapboards and prevented further damage to the building.

S-15473. Nov. 9, 1913, JAMESTOWN, N. Y. A serious fire occurred in a large mill building adjoining a brick worsted mill. A strong wind swept the flames toward the building and windows began to crack. The outside sprinklers were turned on and a solid sheet of water effectively shut off the building from the fire. No inside sprinklers opened and the only damage was to the windows. The open sprinklers undoubtedly prevented a large loss.

S-15639. FEB. 9, 1914, PLAINVILLE, MASS. Fire occurred in a group of frame unsprinklered buildings adjoining a two-story frame sprinklered factory building. The fire spread rapidly and open sprinklers on the exposed side of the factory were turned on. The system consisted of two lines of sprinklers over the windows on the first and second floors, supplied by a 3 in. pipe from a 6 in. street main. The system operated for three-quarters of an hour and the wall of the factory was not even scorched. No inside sprinklers opened. The adjoining buildings were burned to the ground.

S-26430. JUNE 8, 1919, COHOES, N. Y. Fire occurred in a mill building adjoining a brick storage warehouse. The manager happened to be in the building at the time of the fire and immediately opened the valve controlling the open heads at the sixth and eighth floor windows facing the fire. The open sprinklers supplied an effective water curtain and

prevented the fire from entering the warehouse at any point. The intense heat cracked some of the windows and scorched the frames but no inside sprinklers opened.

S-28673. Oct. 15, 1920, Rochester, N. Y. Fire occurred in frame stable and sheds 18 ft. from a one-story sprinklered frame factory. The engineer who lived nearby saw the blaze, ran to the plant and turned on the open sprinklers on the exposed side. These sprinklers operated satisfactorily and prevented the fire from entering the building. A total of 27 heads operated for 1½ hours. The wooden window frames were scorched and thin glass windows were cracked, but fire did not get inside and no inside sprinklers opened. The exposing building was destroyed.

S-29105. Jan. 19, 1921, Worcester, Mass. A seven-story office building of fire-resistive construction with wired glass windows and open sprinklers over each window on the second, fourth, fifth, sixth and seventh floors faced an old frame two-story building which was destroyed by fire. The water curtain saved the building from heavy loss. The glass in the windows was not cracked. (For detailed information on this fire see report on Worcester conflagration in Quarterly, Vol. 14, No. 4, p. 369.)

S-31273. Jan. 19, 1922, Brockton, Mass. The exposed building was a three-story frame sprinklered shoe and blacking factory, adjoining a two-story frame metal clad structure occupied for the manufacture of impregnated felt for box toes and containing large amounts of alcohol.

The windows of the frame wall in three stories overlooking the box toe factory were protected only by a system of open sprinklers supplied by city water. The open sprinklers consisted of one line of heads spaced 10 ft. apart under the cornice and irrespective of window spacing. There were 18 outlets on the system on the exposed wall.

A serious alcohol explosion occurred in the exposing building. Fire immediately followed the explosion and the entire building and its contents were destroyed. Nearly all the windows in the exposed factory were broken by the explosion. The open sprinklers were put into service immediately, preventing any fire from entering the building and any serious damage to the wall. No inside sprinklers operated.

S-32157. March 29, 1922, Wilmington, Del. Fire started in a three and four-story brick building adjoining a four-story brick sprinklered department store. On one side, windows of the exposed building forced the fire across a two to four foot alley. These windows were protected by 24 open sprinklers, one at each window. Although the fire burned fiercely and completely gutted the exposing buildings, the open sprinklers prevented spread of fire to the building. Only one inside sprinkler opened and this was five feet from an open window from which a hose stream was being played.

S-32410. APRIL 30, 1922, PATERSON, N. J. Fire started 50 ft. from a four-story brick sprinklered silk factory in one and two-story frame lumber sheds. The factory was provided with open sprinklers over each window (180 in all). The system was put in service but the fire spread so rapidly that windows were hot before sprinklers were put into operation and about 5000 panes of glass were cracked. The open sprinklers kept the fire from entering the mill. Water was kept on for about one hour and a quarter. No inside sprinklers opened.

NOTE:—See also Fire Report H-14124 on page 291.

Open Sprinkler Failures.

S-3748. JULY 4, 1894, HUDSON, MASS. The factory was a three-story frame sprinklered building exposed by a three and four-story frame shoe factory 50 ft. distant and its one and two-story additions 10 ft. distant. Fire involved the exposing buildings and the open sprinklers were put in operation on the north and west sides of the main factory and on the north of the new building. The fire was successfully fought off for nearly two hours until a high wind came up which blew the spray from the open sprinklers away from the wall. The factory caught fire and was totally destroyed.

Another building similarly exposed, of the same construction and having similar open sprinkler protection, was saved by its open sprinklers, the only damage being due to water entering through windows.

S-3747. OCT. 31, 1894, NEWBURYPORT, MASS. Fire started in a large unsprinklered frame factory adjoining a frame sprinklered shoe factory. The shoe factory was protected by a line of open sprinklers at the cornice, supplied by city mains with pressure of 26 pounds on the top line, a 2500 gallon tank five feet above, and a 500 gallon steam pump draughting from a cistern of 5000 gallons capacity. The pump was started and supplied a hose stream for a few minutes. This practically exhausted the cistern. When the steamers arrived the city pressure was lowered enough to make it of little value to the open sprinklers and all that remained was the small tank feeding both the open sprinklers and the inside heads. The building caught all along the exposed sides and burned very rapidly. It was totally destroyed.

S-1869. MAY 17, 1902, BROCKTON, MASS. The fire started in a frame blacksmith shop 8 ft. distant from a frame sprinklered shoe factory. The fire spread very quickly and in spite of the open sprinklers the heat broke through at the cornice in three places between the open sprinkler heads and opened inside sprinklers. The inside sprinklers prevented further spread of the fire. About 50 ft. of the outside wall was scorched and window frames were burned out.

S-7527. APRIL 19, 1904, TORONTO, CANADA. This building was a brick sprinklered structure involved in the Toronto conflagration. The fire reached a three-story building 15 feet distant. Open sprinklers supplied by a 4 in. connection from a 6 in. city main were located at all windows on the exposed side. Windows on another side were not protected and heat from another burning building 66 ft. away on this side opened many inside sprinklers, draining an 8000 gallon tank. At 1:30 A. M., 3½ hours after fire had entered the nearest adjoining building, the roof caught fire and the building burned slowly until the middle of the following forenoon, when all the floors went down. Long before this time all surrounding buildings had been destroyed. It was a notable example (even with the low pressure, 30 pounds) of the effective barrier which a sprinklered building makes to a conflagration. The outside sprinklers, aided perhaps by the inside sprinklers and the fire department, entirely prevented the fire from gaining entrance through the windows, which were protected by the open system. Fire apparently entered only by way of the unprotected side.

S-10836. DEC. 27, 1910, MONTREAL. The fire started in a four-story brick unsprinklered building exposing two connecting brick and stone buildings across a 10 ft. light court. The windows of the exposed buildings were protected by open sprinklers, 24 heads in all, with city pressure at 25 pounds and control valve in the basement. No one at the fire apparently was familiar with the open sprinkler equipment and it was not turned on. The fire entered the windows and opened a number of inside sprinklers, causing a heavy water damage. The operation of these sprinklers, however, probably prevented the destruction of the buildings.

S-11301. MAY 27, 1911, MONTREAL. Fire started in a large skating rink 30 ft. from a four-story brick sprinklered factory. A water curtain of 76 heads protected the front exposed to the rink. The wind was blowing toward the factory. The public waterworks protection was defective and at the time of the fire there was only nine pounds pressure in the mains. No water reached the open sprinklers or the inside sprinklers and the factory was severely damaged. (For a detailed report of this fire see QUARTERLY, Vol. 5, No. 1, p. 81.)

S-13022. JULY 6, 1912, BOSTON. A three-story frame sprinklered building was severely exposed by a fire in a hay shed 15 ft. distant. Three sides of the building were protected by open sprinklers at the cornice, spaced eight feet apart. Fire passed through the water curtain on the side nearest the fire, entering several stories at once and overtaxing the sprinkler system. The two upper floors were badly damaged. (For a detailed report of this fire see QUARTERLY, Vol. 6, No. 2, p. 243.)

H-8363. DEC. 10, 1912, CINCINNATI. An eighteen-story fire-resistive building was severely exposed by a fire which destroyed an adjoining six-story brick hotel. The windows exposed by the fire were plain glass in wooden frames equipped with open sprinklers supplied by two elevator pumps drawing from a surge tank and four siamese steamer connections. The pumps supplying the open sprinklers were not started until after the window glass was broken, which prevented the maintenance of a satisfactory water curtain. However, the water supply connections would have been inadequate to supply the estimated 3500 gallons per minute necessary. Heavy damage was done to the building on all floors. (For a detailed report on this fire see QUARTERLY, Vol. 6, No. 4, p. 488.)

S-20243. JAN. 29, 1917, HARTFORD. A five-story brick department store was severely exposed across a 10 ft. alley by a fire which destroyed two large department stores. The windows on both sides were plain glass but the exposed building was protected by open sprinklers. All the open sprinklers were put in service shortly after the fire broke out and worked satisfactorily until the increasing number of hose streams in use reduced the pressure on the top lines. The fire department was about to use the steamer connections to the open sprinkler system when the exposing wall fell, stripping the pipes from the building and breaking many windows. Thirty-six inside sprinklers opened and held the fire in check. The upper floors were damaged and heavy water damage resulted. (For a detailed report of this fire see QUARTERLY, Vol. 10, No. 4, p. 425.)

S-35021. JUNE 1, 1923, CANAAN, N. H. A conflagration partially destroyed a 2½-story frame sprinklered factory. Open sprinklers had been placed on the easterly side to protect against a bad exposure in that direction, but as the fire came from the west they were of no value. (For a detailed report of this fire see QUARTERLY, Vol. 17, No. 2, p. 156.)

Wired Glass.

Of the 57 exposure fires where the exposed buildings were equipped with wired glass windows, this protection was satisfactory in 24 cases, failed in 15 cases, and was not a factor in 18 cases. The record clearly shows that wired glass is an effective protection against exposure, particularly if backed up by automatic sprinklers. In severe fires, even if the wired glass stands up, sufficient heat may be radiated through the glass to ignite combustible material, and unless the sprinkler is there to put out small blazes of this sort the value of the wired glass protection is greatly reduced. An analysis of the 15 failures shows that the wired glass melted in 11 cases, radiated heat ignited inside combustible material in three cases, and a falling wall broke the glass in one case.

The tall building is the one described in report S-14597 on page 288. Wired glass successfully withstood the fire, while in the adjoining building fire entered through thin glass in wooden frames opening 47 sprinklers and causing heavy water damage.

Wired Glass Successes.

S-98. MAY 8, 1905, PHILADELPHIA. Fire occurred in a five-story brick unsprinklered tobacco warehouse across a 16 ft. alley from a brick sprinklered building. The latter was provided with wired glass windows in metal sash. These windows were severely exposed by the fire and 117 panes were cracked. In no case did any glass fall from the frames and no inside sprinklers operated. The stock was four feet from the windows and the radiated heat did no damage. The wired glass windows undoubtedly prevented a heavy loss.

H-3961. JULY 4, 1909, PORTLAND, ME. A three-alarm fire involving a carriage factory severely exposed an electric power station 50 ft. distant. The windows on the exposed wall were all protected by wired glass in metal frames. Every window was badly cracked from the intense heat, but no glass fell out and no fire entered the station.

H-5613. AUG. 17, 1910, JERSEY CITY. An eight-story sprinklered warehouse of mill construction was severely exposed across a narrow street by a conflagration involving a block of factory buildings. All the window openings on the warehouse were provided with wired glass in metal frames. Absolute protection to the building was afforded by the wired glass windows. While these were cracked by the heat, no sprinklers opened and no fire entered. (For a detailed report of this fire see QUARTERLY, Vol. 4, No. 2, p. 230.)

S-10442. DEC. 4, 1910, ST. LOUIS. A three-story brick sprinklered factory was severely exposed by a frame lumber shed from 10 to 14 ft. from the wall of the factory. The windows of this building were protected by wired glass in metal frames. An adjoining and connecting building was provided with plain glass in wooden frames. Wind forced the flames against the exposed walls. The wired glass windows remained intact, although some of the brick wall was badly checked. Some combustible material within 16 in. of the wired glass windows was ignited by

the radiated heat. Four sprinklers opened and controlled this fire. (For a detailed report of this fire see QUARTERLY, Vol. 4, No. 3, p. 374).

S-10617. DEC. 22, 1910, BOSTON. The upper stories of a brick sprinklered department store were severely exposed by fire in an adjoining hotel. The windows of the store above the roof of the hotel were protected by wired glass in metal frame. The wired glass was badly cracked but did not fall out. No inside sprinklers opened and no fire entered the building.

S-14597. JUNE 8, 1913, LONG ISLAND CITY. Fire involved some three-story unsprinklered brick buildings across a 60 ft. street from a seven-story fire-resistive sprinklered building with wired glass windows. The heat was carried by the wind against the face of this building and sufficient heat radiated through the wired glass windows to open sprinklers along the end lines. The windows were badly cracked on all floors but no breaks occurred and the fire was totally excluded from the building.

H-10164. JUNE 25, 1914, SALEM, MASS. A brick power house with wired glass windows and metal clad doors at all openings was involved in the Salem conflagration. The wired glass was cracked badly in all windows but no part was missing and the metal frames withstood the fire perfectly. The heat to which the wired glass windows were exposed by fire in an oil storage building across the street is shown by the fact that the paint on an interior door, located seven feet from two of the windows, was blistered and peeled off. Employees remained in the building throughout the conflagration and the plant was put in operation shortly after the fire was over.

H-20132. DEC. 14, 1914, CLEVELAND. A new four-story fire-resistive factory building was severely exposed by an adjoining frame factory which was destroyed by fire. The new factory was provided with wired glass windows in steel sash. While it was exposed to the intense heat of the fire and the brick walls were badly spalled, no fire entered the building and none of the wired glass melted or fell out. The steel sash was warped in places but otherwise was not damaged.

S-22343. JAN. 4, 1918, HOBOKEN. Fire occurred in a building 116 ft. from a ten-story fire-resistive sprinklered building with wired glass in metal frame on all windows. The wind was blowing directly toward this building and the intense heat cracked about 1400 panes of wired glass. No sparks or flame entered the building and no inside sprinklers operated.

H-13648. JAN. 17, 1918, NEW HAVEN. The exposed building was located 1 ft. from a brewery which was totally destroyed by fire. The

A wired glass success. The spalling of the wall indicates the intense heat of the exposing fire. See report H-20132 on page 288.

windows in the exposed wall were wired glass in metal frame. The glass in three windows was cracked but did not fall out. The walls were smoked badly but fire did not enter the building.

H-13049. SEPT. 13, 1919, BROOKLYN. A serious conflagration involved the Sone and Flemings works of the Standard Oil Company and the Columbus plant of the U. S. Industrial Alcohol Company. The Miller Building was a five-story reinforced concrete structure immediately opposite the plant of the U. S. Industrial Alcohol Company across an 80 ft. street. Window openings on this side, 130 in all, were protected by wired glass in hollow metal frames. The building was also equipped with a standard sprinkler system. Following is an interesting description by Mr. P. E. Brown (member N. F. P. A.) of his experience in this building.

Sunday forenoon I went through the Miller Building. At 10 A. M., while I was on the top floor, two more oil tanks at the north end of the Standard Oil plant exploded. The glass in the windows cracked all across the front of the building from the intense heat. The windows were too hot to touch from the inside and an uncomfortable heat could be felt by leaning up against the inside face of the front concrete wall. All stock and combustible fixtures except permanent partitions and work benches on all floors had been moved away from the front wall 20 feet. The ends of cardboard boxes in stock racks 25 ft. from the windows were warm and I judged that the heat at the ceiling along the front windows was between 125 and 150 degrees Fahrenheit. Knobs and latches on stair doors were uncomfortably hot and the outer sides of wooden street doors were charred. Telephone and electric light wires outside and in front of the building had melted away in the heat of the night before, and the telegraph poles had repeatedly caught fire from top to bottom. At times in the course of Saturday night the flames from burning oil appeared to leap across the street and sweep the entire face of the Miller Building. No sprinklers operated.

The heat was so severe that for three hours no hose streams could be operated in the vicinity The wired glass windows deserve full credit for saving the building.

S-31318. AUG., 1921, INDIANAPOLIS. Fire occurred in a frame building 16 ft. distant from a two-story sprinklered fire-resistive factory. The exposing building contained tar, sulphur, and box shooks and made a very hot fire with wind blowing toward the factory. The wired glass windows held and prevented fire from entering the factory. No sprinklers opened.

S-31835. JAN. 10, 1922, PITTSBURGH. Fire occurred in an unsprinklered mercantile building 10 ft. distant from a four-story brick sprinklered clothing store. The windows of the exposing building faced the wired glass windows of the clothing store. The heat cracked the windows but no fire entered and no sprinklers opened.

Wired Glass Failures.

S-7556. MAY 24, 1908, CHICAGO. A two-story sprinklered box factory of mill construction was severely exposed by a fire in frame lumber sheds across a 25 ft. alley. The exposed side of the box factory was provided with wired glass windows in metal sash. A large quantity of cut lumber and boxes was piled close to the windows. This lumber began to char and it was necessary to open 17 sprinkler heads. The wired glass proved efficient with the aid of the sprinklers, but it is certain that it would have failed to keep fire out otherwise as the lumber was charred ¼ in. deep.

S-7518. JULY 13, 1908, ATLANTA. A factory building was severely exposed by a fire which destroyed an adjoining box factory. All windows exposed by the box factory were of wired glass in metal frames (not standard). The heat was intense and 16 of 24 wired glass windows were

entirely destroyed. The other windows were badly damaged. The windows afforded no protection and as the heat became sufficient the glass cracked and warped and drew out of the frames. As the windows gave way, sprinkler heads directly above them opened and prevented fire from entering the building. (For a detailed report of this fire see QUARTERLY, Vol. 2, No. 2, p. 235.)

H-4476. JUNE 24, 1909, PHILADELPHIA. A fire-resistive factory with wired glass windows in metal frames was subjected to severe exposure by fire which destroyed a frame boiler house and grease extracting building adjoining. The heat melted the wired glass windows and fire burned all combustible material inside. The building itself was not damaged. (For additional information on this fire see QUARTERLY, Vol. 3, No. 3, p. 359.)

S-10879. AUG. 13, 1910, CHICAGO. Fire started in a 2½-story frame tenement close to a fire-resistive sprinklered factory. The burning building was close against wired glass windows in metal sash on the factory and the heat was so intense that the glass melted out of the frames and the frames were badly warped in four windows. Three sprinklers opened and controlled the fire with small loss.

S-15348. FEB. 13, 1913, CHICAGO. The wall from a burning building across a narrow alley fell, breaking a wired glass window of a department store. Sparks entered through this opening and ignited rubbish in a vault. Three sprinklers opened and controlled the fire.

H-14124. APRIL 4, 1918, KANSAS CITY. A serious conflagration involved several large warehouses. An eight and nine-story building of fire-resistive construction of large area was in the direct path of the fire and severely exposed. The building was protected with a standard sprinkler system and wired glass windows. The intense heat melted out the windows protecting openings in the east wall and opened sprinkler heads in this section. Fire also communicated through large wired glass windows in the south wall, a total of 265 heads being opened. The south wall was protected by open sprinklers into which the water supply was turned on a short time after fire was discovered. A water curtain was formed which rendered excellent service in preventing fire from making progress and communicating into the interior of the building. The loss to the building was about 15 per cent and to contents 30 per cent.

S-27726. APRIL 11, 1920, CHICAGO. Fire started in a five-story unsprinklered brick building adjoining a seven-story fire-resistive sprinklered building. The heat radiated through standard wired glass windows two stories above the roof of the burning building, scorched and finally ignited a wooden partition. Two sprinklers opened and extinguished the fire with small loss.

Courtesy Fire and Water Engineering.

The fifth and seventh floors of this Stockton, California, office building were gutted on July 30, 1923, when heat from an exposure fire radiated through wired glass windows. See report H-20131 on page 293.

S-28023. APRIL 20, 1920, BROOKLYN. Fire in an adjoining building exposed a six-story brick sprinklered furniture factory. The heat became so intense that non-standard wired glass windows melted and fell out of hollow metal frames, allowing sparks to enter the building and ignite material on the third and fourth floors. Twenty-five sprinklers opened and extinguished the fire.

S-28098. JUNE 23, 1920, BALTIMORE. The fire started in a five-story brick mercantile building adjoining a six-story fire-resistive building. The fire was so intense that 1¾ in. tin clad shutters protecting windows in a light court gave way and double glazed wired glass windows on the three upper floors were melted. The fire was controlled by the public fire department.

S-29070. JAN. 19, 1921, WORCESTER. Fire from adjoining buildings involved in the Worcester conflagration melted out wired glass windows in a three-story mill construction building and badly damaged the building. (For detailed information on this fire see report on Worcester conflagration, QUARTERLY, Vol. 14, No. 4, p. 372.)

S-32244. MARCH 22, 1922, NEW YORK. Fire occurred in a ten-story fire-resistive unsprinklered building exposing a 17-story fire-resistive sprinklered building across a 10 ft. light well. The windows of the latter were protected by wired glass in metal frames. The fire caused the wired glass to crack and fall out in part from the second to seventeenth floor. Some stock in paper boxes stored on the window sill at the tenth floor. ignited. One sprinkler operated and extinguished this fire.

H-20131. JULY 30, 1923, STOCKTON, CAL. A ten-story fire-resistive office building was severely exposed by a fire in a three-story brick hotel of large area adjoining. Window openings above the hotel were protected by approved wired glass in metal frames. The heat generated by the fire was intense and its full force was directed against the office building. Fire gained entrance on the fifth and seventh floors, mainly through the radiating heat igniting wooden trim, curtains and other combustible materials near the windows. Melting of the wired glass at a temperature higher than that for which it was intended may have allowed the fire to have entered directly in some cases. The fifth and seventh stories were completely gutted. (See illustration on opposite page.)

Tin Clad Shutters.

There are in the fire record 46 exposure fires involving tin clad shutters. In 18 of these the shutters successfully withstood the fire and in 14 the shutters did not protect the building. In 14 the shutters were not a factor. It is clearly shown that standard shutters, *if closed,* give

excellent protection against severe exposure. Heat does not readily pass through the shutters and in only one or two cases sufficient heat came through to ignite combustible material close against the shutter inside.

Nine of the fourteen failures were due to the fact that shutters were not closed. It seems reasonable to class these nine fires as tin clad shutter failures. The chief weakness of this form of protection against exposure is the fact that the human element enters strongly into their usefulness. An open shutter that cannot be closed because of rusted hardware is no better than a plain glass window. The fact that shutters have been placed on a building does not mean that the building has been protected against exposure unless the shutters are kept permanently closed, or arrangements are made which will ensure their closing when needed.

Tin Clad Shutter Successes.

S-744. FEB. 23, 1900, PHILADELPHIA. A serious fire occurred in a six-story building 10 ft. from a five-story building protected by standard fire shutters. The shutters withstood severe heat for over an hour, although a high wind blew a continuous sheet of flame and sparks against and over the building. The fire burned through the roof and damaged the top floor but no fire came through the shutters.

S-2998. APRIL 19, 1904, TORONTO. The building was a four-story brick structure involved in the Toronto conflagration. There was one window in the south wall facing an adjoining burning building. This window was provided with a 2 in. standard shutter. The outer covering of this shutter remained intact, although subjected to intense heat. Employees with standpipe hose kept fire from entering unprotected windows on another side and the loss to the building was small.

H-164. MAY 7, 1904, PITTSBURGH. Fire occurred in a one and two-story brick unsprinklered carriage factory adjoining a department store. Employees closed the shutters at windows facing the fire and no fire entered the building. The fire was a hot one and flames reached nearly to the sixth floor. The shutters undoubtedly prevented a heavy loss.

S-4430. OCT. 24, 1909, NEW YORK. A sprinklered factory building was severely exposed by a fire in a two-story frame unsprinklered building adjoining. There were ten windows facing the fire protected by tin clad shutters. These were closed at the time and successfully kept fire out. No sprinklers opened.

S-14862. JUNE 15, 1913, BRIDGEPORT. Fire in a 2½-story frame rag shop severely exposed a three-story brick sprinklered factory 10 ft. distant. The exposed face of the factory was protected by tin clad shutters. These shutters were exposed to intense heat and several were entirely

These windows, in a building destroyed in the San Francisco conflagration, were protected by wired glass windows and metal clad shutters. The intensity of the fire, which practically destroyed this double protection, is apparent.

burned off and the wooden core reduced to charcoal. Sprinklers opened and controlled the fire that reached the inside. The shutters undoubtedly prevented a heavy loss. (For a detailed report on this fire see QUARTERLY, Vol. 7, No. 2, p. 221.)

S-15423. OCT. 15, 1913, TROY. Fire started in a group of frame icehouses 20 ft. from a four-story brick sprinklered factory. The fire was very severe and the fire department could not cope with it. Tin clad shutters on the factory held excellently with no indications of failure in any instance. No sprinklers opened.

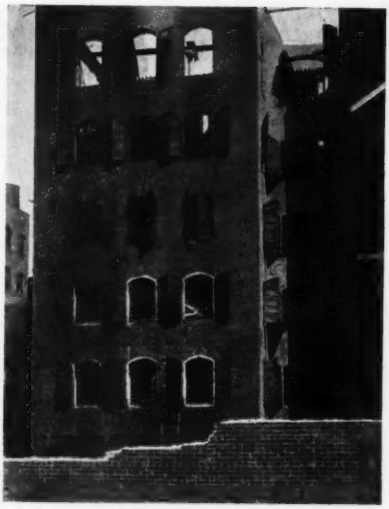
S-20965. JUNE 4, 1917, BOSTON. A serious fire involving several buildings occurred across the street from a four-story brick sprinklered factory. A high wind was blowing toward the factory and without much doubt the building would have been destroyed or a large water loss from sprinklers would have ensued if the front of the building had not been equipped with shutters. These were closed promptly and successfully prevented any fire from entering. No sprinklers opened.

H-16605. JUNE 23, 1920, BALTIMORE. A seven-story brick sprinklered building was severely exposed by a fire in a five-story brick unsprinklered building 18 ft. distant. The brick walls were badly spalled and the tin clad fire shutters were badly bulged and twisted and nearly charred through. The fire, however, did not enter the building. A few sprinklers near windows opened.

H-18021. Nov. 26, 1921, AUGUSTA, GA. A five-story sprinklered building of mill construction directly adjoined several buildings involved in a conflagration. The tin clad shutters were closed and although the wood fillers of the shutters were burned out and the intense heat opened the sprinklers nearest the wall, the fire was checked here, the building suffering little damage. (For detailed information on this fire see report on Augusta conflagration, QUARTERLY, Vol. 15, No. 3, p. 282.)

Tin Clad Shutter Failures.

S-12160. FEB. 6, 1912, PHILADELPHIA. A sprinklered factory was destroyed by a severe exposure fire because of a combination of unfavorable circumstances. The weather was below freezing, a strong wind carried the fire toward the exposed building, and hydrants were frozen. The sprinkler equipment had frozen up. The fact that tin clad shutters on the exposed wall were poorly designed (those on fifth floor were twelve feet high) was an important factor in admitting fire into the building, but it is a question whether full standard shutters could have withstood such a severe exposure.



Fire started in the building to the rear of this factory (from which the photograph was taken) and spread to the factory through the window openings, the shutters being open. It was the custom of this company to close their shutters only on Saturday night.

S-15632. JAN. 29, 1914, LYNN, MASS. Fire occurred in a three-story frame building 9 ft. distant from an eight-story brick factory. The fire spread to the window casings on the second, third and fourth floors where shutters were not closed. Sprinklers operated and held the fire in check. Shutters where closed proved a good protection and it is very probable that had all shutters been closed no damage would have resulted.

H-10435. SEPT. 3, 1914, PORTSMOUTH, O. The fire started in a group of one and two-story frame buildings exposing a four-story opera house. The windows of the opera house were provided with tin clad shutters which normally remained open and were rusted fast in that position. Efforts were made to close the shutters without success. The opera house was totally destroyed.

H-10634. NOV. 9, 1914, READING, PA. Fire in a lumber yard exposed a brick unsprinklered factory. On the windows overlooking the yard were two-ply double lock jointed tin clad shutters. These shutters did not overlap the windows but were hung inside the brick work flush with the exterior wall. The sills of the windows were made of stone built on a slant for drainage and the shutters did not fit closely against the sill. The shutters were all closed at the time of the fire but flames entered through the space between the shutters and the sill. The building was badly damaged.

S-28100. JUNE 23, 1920, BALTIMORE. Fire started in a five-story brick unsprinklered building across a narrow light court from a six-story brick sprinklered building. The windows of both buildings were protected by 1¾ in. tin clad shutters. The shutters on the fourth and fifth floors of the exposed building were closed but were forced open by smoke and gas explosions in the burning building. Intense heat ignited wooden frames and sash behind other shutters. All shutters were badly damaged and bulged on both sides. Firemen prevented fire from spreading inside.

S-29063. JAN. 4, 1921, SOUTH NORWALK, CONN. Fire occurred in a four-story brick building adjoining a four-story brick sprinklered building. The fire communicated to a two-story frame addition to the exposed building. Windows of the building overlooking the roof of the addition were poorly protected by substandard shutters in wooden frames, the shutters being inside the building and opening inward. The flames reached the unprotected windows and burned out the woodwork, causing 39 sprinklers to operate. Some of the shutters were pushed in by hose streams from outside. The sprinklers controlled the fire.

Iron Shutters.

Reports on only thirteen fires involving iron shutters as protection against exposure are available for this record so that no general conclusions may be drawn as to the efficiency of this type of protection. In one case flat framed iron shutters furnished good protection against a severe exposure. In another case thin iron shutters kept a hot fire out of a factory building until the fire department arrived. In six cases thin iron shutters furnished little or no protection against the exposing fire, and in two cases the shutters were not closed. The iron shutter is obviously of little value if combustible material is piled against it, as it heats up rapidly and in a hot fire reaches a sufficient temperature to ignite combustible materials in contact with it in a comparatively short period of time. Like the tin clad shutter, the iron shutter depends upon the human element; it is of no value when not closed.

With one or two exceptions the fires where iron shutters were involved occurred more than twenty years ago, and the details given in the reports are rather meagre. On this account no detailed summaries are given in this class.

The Hotel Margaret Fire.

A fire which occurred at 8:45 P. M. on November 23, 1923, destroyed the roof and the contents of the eleventh floor of the Hotel Margaret in Brooklyn, N. Y. The hotel is an eleven-story ordinary brick building with wooden lath and plaster finish and partitions. The floors are single ⅞ in. boards on wooden joists. There are two elevator shafts of wooden lath and plaster, and one open stairway.

The hotel was provided with one 3 in. standpipe having branch lines to three outlets on each floor with 50 feet of 2½ in. unlined linen hose attached to each outlet. This standpipe was supplied by a tank on the roof and had a siamese connection on the street. There are four fire escapes on the outside of the building.

The fire started from unknown cause in a clothes closet in one of the guest rooms on the eleventh floor. A guest in the sun parlor under the roof noticed flames coming through the floor. He ran down to a room on the floor below and procured a pitcher of ice water which he poured on the blaze without effect. He went to the elevator and told the operator to get the manager. An assistant manager soon appeared and dashed back to the elevator and down to the main floor where he got an extinguisher. This had little effect and he notified the telephone operator to warn all the guests. In the meantime a clerk had sent in an alarm.

The building is located in a separate fire main district and a pump at the main station was started, bringing the water pressure to 125 pounds. At 9:08 a third alarm was sent and at 9:12 a second pump was started, the pressure being increased to 150 pounds. At 9:12 a fourth alarm was sent in and a few minutes later (9:22) the pressure was increased to 200 pounds. Subsequently the pressure was increased to 250 and 275 pounds for a short period. These high pressures were necessary because of the height of the building and the inadequate capacity of the standpipe. The fire department, finding that they could not depend upon the standpipe, stretched hose from the street to the upper floors and also used a water tower.

All of the guests were able to get out of the hotel without injury. In view of the poor construction and inadequate protection of this building it is fortunate that the fire occurred on the top floor.

Dyestuff and Intermediate Plants.

A Fire Record Analysis.

By W. D. Milne.
(Member N. F. P. A.)

To introduce an effort to state the fundamental measures necessary for reasonable safety from severe fire loss in plants engaged in the manufacture of the so-called coal tar dyestuffs and intermediates, a review has been made of the reports of fires in plants so engaged as found in the fire record files of the National Fire Protection Association.

As the manufacture of materials of this sort has only rather lately become extensive in the United States, reports of fires prior to 1912 were omitted from the review. Reports on a number of fires were omitted from the tabulations on account of lack of data in any measure illuminating as to the hazard causing the trouble. Reports of 134 fires were examined with care, and while in many cases the information was in some measure unsatisfactory, either on account of the destruction of the evidence and the death of operators, on account of the reticence of owners, or by lack of understanding on the part of the observers, the evidence contained in these 134 reports is highly instructive, and indeed impressive.

The review of these reports indicates that a very large proportion of the fires were due to special hazard conditions as distinct from the common hazards of power, lighting and heating, that loss of life was involved in an unusually large number, and that the property loss per fire was much higher than in the more common classes of manufacturing plants. No tabulations on these features were made as many of the reports were not sufficiently complete to give satisfactory results. The reports were, however, reviewed to ascertain if possible the relative importance of (a) certain well defined chemical processes, (b) certain common machines or apparatus, and (c) the particular materials involved; and to discover, if possible, if the actual fire record supported the fear that is felt by fire underwriters in regard to the hazards of this industry.

Chemical Processes.

Among the more prominent chemical processes found in the manufacture of organic chemicals are the following:

(1) Sulphonation
(2) Chlorination
(3) Nitration
(4) Reduction
(5) Distillation
(6) Sublimation
(7) Fusion

Of the 134 fires, 66 were more or less definitely connected with these processes. They may not have been caused directly by the process, but the loss was due to the conditions presented by the process, the exact cause of the ignition being a matter of secondary importance. A number of other fires involved processes either unusual or poorly described in the reports.

(1) SULPHONATION: This may be described as the process of treating a hydrocarbon with sulphuric acid. The reaction is almost always attended by the evolution of heat, and is sometimes encouraged by application of heat or pressure.

Six fires from this process were found, three in sulphonating benzol, one in aniline oil, and two in naphthaline and beta-naphthol in the manufacture of "H" acid.

The three fires incident to the treatment of benzol started with flash fires in the benzol vapor evolved from the material in the reaction.

The two fires which involved naphthalene were characterized by flash fires in the vapor or crystals of sublimed naphthalene from the process, which had collected at the ceiling of the room. In both these cases there was fire heat for the process.

The fire involving aniline oil occurred in wooden hood and vent and involved an initial flash.

(2) CHLORINATION: The term "chlorination" as used in the reports under review appears to mean the treatment of a material with hydrochloric acid, but not solely the process of reduction.

Five fires involving this process were found, one with benzol, one with toluol, two with aniline oil and one with a substance not named. In one of the fires with aniline, fire started in a room where a gas heated kettle was left unattended with the reaction in progress. The loss was $99,000. In the other the contents of the kettle leaked out or overflowed into the open flame heating it. In the fire with benzol, vapor from the material which had leaked from a kettle was ignited by the breaking of a portable electric lamp bulb. In the case of the toluol, the closed retort in which the reaction was proceeding ruptured and the escaping vapors ignited. In the other case, the kettle was oil jacketed and gas fired. A crack in the kettle let the oil into the combustion chamber and a severe fire ensued.

(3) NITRATION: This process consists in treating an organic material with mixed sulphuric and nitric acid, or more rarely, with sodium nitrate and sulphuric acid.

Seventeen fires directly connected with the nitration process were found in the record. The record is known to be very incomplete in regard to the fires in this connection, and the review does not include fires in connection with the nitration of cellulose and materials of that order.

Of the 17 fires, 5 were in nitration of benzol or nitro-benzol, 3 in chlor-benzol, 5 in toluol or nitro-toluol, 2 in phenol or sulphonated phenol, one was due to torch being used to repair lead lining of nitrator, and one was an explosion in a nitrating plant, in which all evidence of the origin was wiped out.

In ten of the instances there were explosions of one kind or another, consisting either of rupture of the nitrators or their covers, or explosion of vapor clouds in the building, or both. The remainder were nearly all vapor flash fires of less violence.

The specific causes for these fires were given in six cases as "too violent reaction" or "reaction proceeding too fast." In one case toluol backed up through pipes into a tank of mixed acid causing reaction and explosion. In three cases electric sparks from motors or lighting apparatus were blamed for ignition of vapors. In two cases vapors were ignited by the open flames used in heating retorts, and in one from gasoline torch used in repair work. In the other four cases there was no evidence of the immediate cause.

The evidence as regards the hazard of high as against low nitration is not sufficient to be of value, though four of the above fires involved nitration of nitro-toluol or nitro-benzol.

(4) REDUCTION: For the purposes of this tabulation "reduction" is interpreted to designate only the process as carried out with zinc dust, although other fires occurred in connection with reactions effecting reduction by other means.

One fire was reported as due to a too violent reaction of nitro-toluol in alcohol solution with zinc dust and caustic soda. The apparatus was ruptured and there was a secondary explosion in the vapor cloud liberated.

(5) DISTILLATION: This is perhaps the most common process found in chemical works, since it is used in refining or purifying a great variety of liquids. It is somewhat difficult to distinguish in fire reports between the ordinary distillation and sublimation processes, and reports on trouble in connection with apparatus designated as "subliming stills" are grouped under the heading of sublimation. Perhaps neither should be rightly classed as a *chemical* process, but the circumstances may be so considered.

Thirteen fires in connection with distillation were recorded. The materials involved were mono-nitro-toluol, one case; alcohol, one; aniline oil, two; nitro benzol, one; petroleum oil, one; nitro chlor-benzol, one; phenol compound, one; dimethyl orthotoluidine, one; glycerine, one; carbolic acid or phenol, two; toluol, one.

In eight of the cases trouble either was due to giving away of some part of the still through corrosion or weakness, or resulted in rupture due to development of internal pressure. In six cases direct fire heat for the

still was a factor in the fire. In practically all the cases the flash or explosion of escaped hot vapors was a predominating factor.

(6) SUBLIMATION: This process may be described as distilling a material in which the condensation product is deposited in the form of solid particles.

Twenty-one fires and explosions are recorded in this group. The material offending in seven cases was naphthalene, in three cases salicylic acid, in three cases phthalic acid or phthalic anhydride, in three cases alpha or beta naphthol, in three cases anthraquinone, in one case B-naphthylamine, and in one case bezanthrone. Some of the explosions and fires were most disastrous, and the seriousness of the hazards is not well emphasized by this tabulation alone.

In four of the cases the trouble was attributed to overheating or improper operation of the still, while in five others the trouble apparently originated from ignition of dust in the subliming chambers. In five cases flash fires started in escaped vapors or sublimed particles in air of the work rooms, while in three others the hot liquid overflowed or leaked out. In two cases hot residues drawn on account of interruption of process caught fire, apparently spontaneously. In two cases fire resulted from poorly arranged fire heat for the subliming kettle, involving the material being treated.

(7) FUSION: This may be described as a process in which substances are melted together in fire heated pans or kettles. A number of reports covered fires in connection with fire heated kettles, the process being carried on not being clearly stated.

In three fires in fusion pans as defined, benzenesulphonic acid in the manufacture of phenol was involved, and in one, sulphur and anthracene. In the report on the latter case the occurrence was said to be common.

Machines and Equipment.

The frequency of fire in connection with the more common mechanical devices used in the organic chemical plants is instructive as to the nature of the hazard. The following tabulation indicates the fires which prominently involved the physical and mechanical features rather than the chemical features of the processes, though in a number of cases both were important factors. It should be constantly borne in mind that the important factor to be ascertained is the cause of the loss, not the immediate cause of the fire.

The tabulation of the record is made under the following divisions, a total of 88 reports being found to indicate physical rather than chemical processes being involved. (Some of these reports were included in the preceding tabulation.)

(1) Dryers
(2) Grinders
(3) Fire heated kettles, stills and fusion pans.
(4) Steam heated kettles, stills, etc.
(5) Storage tanks and conveying pipes.
(6) Oil heating apparatus.
(7) Electrical apparatus.
(8) Laboratories.
(9) Miscellaneous.

(1) DRYERS: Reports on ten fires in connection with drying processes were found. Of these five were in steam heated dryers, one in hot water heated dryer, two in fire heated drying ovens, while in two cases the method of heating was not given. Two of the dryers were described as of wooden construction, while six were of metal or other non-combustible material. In six cases the use of wooden trays was noted.

The materials being dried were as follows: "dry colors," two; sulphanilic acid paste, two; alpha naphthylamine, one; Azo colors, two; "Alizarine Brown R," one; sulphur colors, two.

(2) GRINDERS or grinding operations gave rise to twenty-one fires. Barrel or ball mill type grinders figured in eight cases, in two of which it was specified that bronze balls were being used. High speed grinders of a type frequently used in sugar and cocoa grinding, figured in six cases. In one case a German "Perlplex" magnetic mill was specified. In the other cases the type of mill was not stated.

The substances being ground were described as follows: benzidine with nitro benzol and alcohol, one; Azo dye, one; mordant chrome, one; chrome yellow, two; "brown synthetic color," one; "Alizarol yellow G," three; "Alizarol brown R. B.," three; C G X yellow, one; "Sulphur Green T," one; "Methylene Green B," one; hexamethyltetramine, one; "Yellow R," one; "Chrome black," one; not stated, three.

All these occurrences were typified by explosions or flash fires, or both. In some cases the charges in a number of ball mills were burned out almost simultaneously, while in others the fire extended through connected grinders, mixing tubs and dust balloons. These occurrences showed the typical features of all dust explosions and some were extraordinarily destructive, involving heavy losses on goods stored in the same room with the grinders, by reason of the fire that ensued.

(3) FIRE HEATED KETTLES, pans, stills and autoclaves figured as essential factors in thirty cases. Of these, there were six cases of fire heated apparatus under pressure when rupture in some part occurred. There were eleven cases in which overflow or leak into the fire box was involved. There were three cases in which oil in oil jackets overflowed or was ignited. There were three cases in which the contents of the kettle were ignited, and four fires which were due to the furnace setting or the fuel itself. Ignition of vapors by the flame of the heating fire was assigned in three cases.

(4) STEAM HEATED KETTLES, stills, autoclaves, etc., figured in seven cases, and probably in a number of others. The steam heating did not have a special bearing on the fires, but the instances are cited to indicate that fire heat is not the only source of danger in connection with apparatus of this kind.

(5) STORAGE TANKS and conveyor pipes for materials figured in three cases apart from those in which stored materials became involved in fires starting from other conditions. In one case a pipe used for conveying benzol leaked on to a roof, and the benzol becoming ignited, possibly by locomotive sparks, set fire to the roof. In one case nitrobenzol leaking from a pump handling it, was ignited from an electric motor. In the other case the leak was from a broken gage glass on benzol storage tank, and in the fire which followed other gage glasses were broken and the automatic stop valves on the gage connections failed to stop the flow. Other cases of this kind are known and in view of the extensive use of gage glasses on containers for hazardous liquids in connection with chemical operations, the matter appears to be one of importance.

(6) OIL HEATING APPARATUS: Process kettles are not infrequently heated by the circulation of hot oil, and while this method is preferable to fire heat, it is not without hazard, as witnessed by five fires. In two cases the trouble started in the room where the oil was being heated, once from overflow of expansion tank, and once from the back fire of a furnace. In one case a circulating oil pipe burst and in another case a pipe leaked, the oil becoming ignited from other process furnaces. In one case a torch being used to repair oil piping ignited oil which had escaped.

(7) ELECTRICAL APPARATUS furnished the immediate cause of seven fires. Sparks from motors, frayed lamp cords, and broken electric light bulbs, in the presence of inflammable vapors, all played their part. One fire from an electrical cause occurred in the wet occupancy of an Azo process room.

(8) LABORATORIES were the scenes of six fires cited in the record. Bunsen burners under glass containers of inflammable liquids gave rise to five, and spontaneous ignition of waste chemicals caused the other.

A number of fires not included in the above summary arose from a variety of causes, including apparent spontaneous ignition of solids or of freshly liberated gases.

Materials Involved.

The materials principally involved in the total of 134 fires were identified according to the number of occurrences as follows, there being some duplication on account of more than one material being involved as in

fires in connection with nigrosine manufacture where aniline and benzol or nitro-benzol are present together:

Aniline	10	Naphthylamine	1
Alcohols	4	Phenol	6
Anthraquinone	2	Nitro Phenol	1
Benzol	10	Paraphenylene diamine	1
Chlor-benzol	3	Petroleum oils	5
Nitro chlor benzol	2	Picric acid	2
Nitro benzol	9	Picramic acid	1
Bezanthrone	1	Phthalic acid, etc.	3
Carbon bisulphide	2	Sodium Nitrate	1
Dimethyl ortho toluidine	1	Sodium Sulphide	1
Glycerine	1	Toluol	6
Miscellaneous	10	Nitro Toluols	5
Naphthol	4	Various colors being ground	
Naphthalene	8	or dried	31

Conclusions.

The 134 fires covered by this review are known to represent only a small portion of the fires that have occurred in this country in connection with the manufacture of the so-called coal tar products, but they may be safely assumed to indicate the nature of the predominating hazards.

Reduced to simplest terms, the hazards of manufacturing plants of the class here considered are primarily the hazards of inflammable volatile liquids and solids, and of inflammable dusts and finely divided materials. These hazards appear under severe conditions, the dangerous materials involved being subjected to processes violent in their physical or chemical actions.

There is ample evidence to show flagrant disregard of the established rules for safety in handling the dangerous materials involved in these fires, and in fact of many of the common safeguards. It is hardly fair to be too critical of those whose enterprise has brought from the chaos of war conditions and experimental effort an industry which promises a bright future, but it is necessary to learn from the mistakes of the past and to consult as to the means by which the industry may be relieved of an excessive fire loss cost. The dispositions for safety must be made to harmonize with the conditions imposed by the necessity of manufacturing at a profit. The problems are not ones to be solved by the chemist, they are ones to be solved by the engineers who design and equip the plant, and by fire protection engineers and by those responsible for discipline, and the conduct of processes in the operation.

Sacrifice of safety for manufacturing expediency has been the bane of recent industrial development, and that the coal tar products industry has suffered severely from it is amply attested by the reports under review. That manufacturing profits have been wiped out by fire in many instances is well shown.

A plan for the comprehensive study of fire protection for chemical plants of this order should embrace certain features suggested by the following tentative outline:

(1) Location and Site.
(2) Plant Layout.
    Standard separation of building units with allowance for expansion.
    Location of spur tracks.
    Location of individual process buildings.
    Location of storage buildings.
    Location of power plants.
    Location of storage tanks for acids and oils, etc.
    Isolation of hazardous buildings.
(3) Building Construction.
    Choice of materials according to occupancy.
    Choice of type according to occupancy.
    Provision of cut-off walls.
    Isolation of hazards from high value areas.
(4) Plant Equipment.
    Choice of types of equipment.
    Arrangement of fire heated devices.
    Arrangement and type of dryers.
    Arrangement and type of grinders.
    Arrangement of safety valves and relief vents.
    Provision of safe electrical equipment.
    Selection of safety valves, automatic stops, etc.
(5) Plant Protection.
    Hydrants.
    Location of underground mains.
    Automatic sprinklers.
    Water supplies.
    Special forms of protection, foam, etc.
(6) Plant Operation.
    Watch and guard service.
    Cleanliness, plant inspection.
    Inspection of fire appliances.
    Inspection of safety devices.
    Supervision of conduct of operations.
    Testing of pressure devices, etc.

NOTE.—The chief object of the publication of the foregoing analysis is to promote discussion and criticism. The purpose of the National Fire Protection Association is to encourage the study and understanding of fire hazards, and in this particular case any contribution of knowledge or experience will be especially welcome.

Fires in Which There Was Loss of Life.

These notes are intended to point out typical conditions under which loss of life has occurred, that they may be known and guarded against.

Cork Dust Explosion.

S-36283. BROOKLYN, N. Y., Nov. 8, 1923. The fire occurred at 6:15 P. M., shortly after work had stopped, in the boiler room of a cork flooring factory where cork sheets are cut, sawed, planed and sanded. Dust from the sanders is blown to a cyclone collector near the ceiling of boiler room and then falls directly to the fire box of an upright boiler. The fire was discovered near the ceiling of the boiler room around the dust collector. Three employees used two lines of hose and apparently had the fire out. Two of them left the room to see if there was any fire elsewhere when there was a severe explosion in the boiler room. The man who was in the room ran out with his clothing ablaze. An employee in the office seized him as he ran past and extinguished the fire with a coat. He died later in a hospital. Another employee in the engine room adjoining was burned but not fatally.

The explosion was due apparently to a collection of finely powdered cork dust mixed with air becoming ignited by the fire at the dust collector. The explosion blew out a portion of the wall, some corrugated iron siding and some skylights. Sprinklers opened and extinguished the ensuing fire.

This fire is another illustration of the fact that finely powdered cork dust when mixed with air and ignited may explode with considerable violence.

The existing conditions were ideal for such an occurrence. They consisted of a direct discharge of cork dust from the cyclone collector to the fire box of the boiler. The same dust collector also vented into a large container (a disused boiler furnace) where the explosion occurred.

Open Fire and Creosote.

H-20116. COLDWATER, MISS., OCT. 25, 1923. A track gang was unloading timbers heavily saturated with creosote from cars. The clothing of the workmen had become soaked with creosote. The morning was chilly and a fire had been kindled beside the tracks. One of the men went too near the flames and his clothing ignited. Other men in the group feared to go to his assistance because their clothing was also saturated with creosote. A bystander seized the burning man and held him while he cut his clothing away with a knife. The man died from the burns and the man who came to the rescue was severely burned.

School.

H-20087. UTICA, MISS., Nov. 6, 1923. A fire occurred at 11:30 P. M. in the Utica Normal and Industrial Institute, a school for colored boys, at Utica, Miss. The building was constructed of hollow concrete blocks. It measured 66 x 100 feet, three stories high, with an open stairway to the third floor. There was no outside fire escape or outside fire protection. The trustees considered the building entirely safe, as a watchman was continually on duty on the lookout for fires and the doors at the entrances were kept open at all times. The electric lighting was safely installed and the current turned off some time before the fire. The fire was discovered by a 17-year-old boy who was detailed to act as watchman. He saw the window sill of one of the upper rooms on fire and immediately rang the fire bell and called out the alarm and proceeded to take his trunk out. He stated that by this time most of the boys were leaving, saving their personal effects. The room in which the fire was discovered was used to store athletic supplies, and was always kept locked. No one had been in this room for twenty-four hours preceding. Directly through this room the chimney of the heating plant, which was an unlined concrete block affair, passed out to the roof, the room being on the third floor. The fire was undoubtedly due to the splitting of this chimney.

There was no fire protection in the building of any kind and the fire gained rapid headway. The fire lasted only forty-five minutes and left only the broken walls and ornamental front. Some of the boys who were engaged in saving their property had to jump from the third story to some mattresses which had previously been thrown from the windows. Several were injured in this way. Two boys lost their lives. Both boys had been seen by others on the second floor of the building and had evidently returned to the third floor to save belongings of others or possibly their own. One body was discovered in the ashes beside the trunk belonging to another boy. The other body was found in the basement. The boy had evidently been overcome by smoke on the stairway.

Gasoline.

H-20186. BINGHAMPTON, N. Y., Nov. 26, 1923. A woman purchased two gallons of gasoline to do some dry cleaning in her apartment. She was cleaning a silk sweater and the gasoline ignited, presumably from static electricity generated by rubbing the silk. The flash enveloped the woman in flames and she was so badly burned that she died soon after. A woman in the next room who came to the rescue was also severely burned. The heat of the fire was so intense that the glass melted out of the windows. It was stated by other occupants of the building that the victim had repeatedly brought correspondingly large quantities of gasoline to her apartment and that they had remonstrated with her without avail.